# Engineering News

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## Skating Rinks Above Water-Works Reservoirs, Reading, Penn.

By Mandes Golder*

The necessity of covering two of the water-works distributing reservoirs of the city of Reading, Penn., in 1909, afforded an opportunity to provide the city with two municipal open-air skating rinks, which, it is believed, are the first of their kind in this country.

During freezing weather the rinks are flooded for ice skating, while during the remainder of the year they are open for roller skating. In the summer of 1911, the Reading Play Grounds Association obtained permission to use one of the rinks for playground purposes. The association furnished music, taught dancing, basket making, blanket weaving and calisthenics.

The Penn St. reservoirs are located at the entrance to the city park and, to general appearances, are part of the park. The reservoirs, built over 45 years ago, were uncovered until 1909, when it became necessary to cover them, since thereafter they were to store filtered instead of unfiltered water.

Before the adoption of the skating-rink plan, many other ideas were advanced as to how the covered space could best be utilized for the good of the public; some of these were: to build tennis courts, general playgrounds, flower beds and grass plots, etc. All these were given up in favor of the rinks as the primary purpose to which the roofs of the filters would be devoted. As already stated, however, these areas served as general playgrounds during the summer of 1911.

Each skating rink is approximately 130x250 ft. in plan, and consists of a 6-in. concrete slab laid on a rolled cinder fill, which in turn rests on a groined-arch construction. A 6-in. curb around the rink forms a dam for the water and ice during the ice-skating season. In the middle of the rink a pavilion is built in which are benches (see Fig. 1). Electric lights are spotted on the pavilion and around the rink, allowing skating in evenings. Sanitary drinking fountains are built at the entrance to the rinks, which supply filtered water. In addition to these fountains, ice-cooled filtered water is supplied during warm weather, through a cluster of eight sanitary drinking fountains, located close to the rinks.

The groined-arch construction under the reservoir (Fig. 2) was designed for a live load of 150 lb. per sq.ft. and for the computed dead load.

To take care of the unbalanced thrust produced by placing the live load over one-half of the arch only, concrete struts were introduced at the springing line of the arches. The struts were designed as arches to carry their own weight and enough concrete was added to take the unbalanced horizontal thrust in compression.

The rink slab is sloped toward the pavilion, at each corner of which is a drain. These drains connect to a 6-in. wrought-iron pipe, which discharges into nearby gutters. Owing to the rectangular shape of the rinks, the grade of the slabs varies from 0.003 to 0.005.

The original reservoirs had puddle floors and stone side slopes. A 5-in. concrete floor was placed over the original puddle floor, while the side slopes were repointed and plastered. To avoid crippling the water supply the reservoirs were covered one at a time.

The north basin was put out of service first, covered, tested and put into service, after which the south basin was covered.

To flood the rinks for ice skating it is only necessary to connect to a nearby fire hydrant. The rink is drained through a 6-in. wrought-iron pipe, as described above.

During the ice-skating season the ice is frequently planed to remove the irregularities and ruts formed through continual skating. For this purpose an ice plane was secured. The plane is drawn by a single horse and leaves the ice in a good skating condition.

Fig. 1. View of Skating Rink over North Basin of Penn St. Water-Works Reservoirs, Reading, Penn.
(Roller skating is practiced in summer. In winter, the area is flooded for ice skating.)

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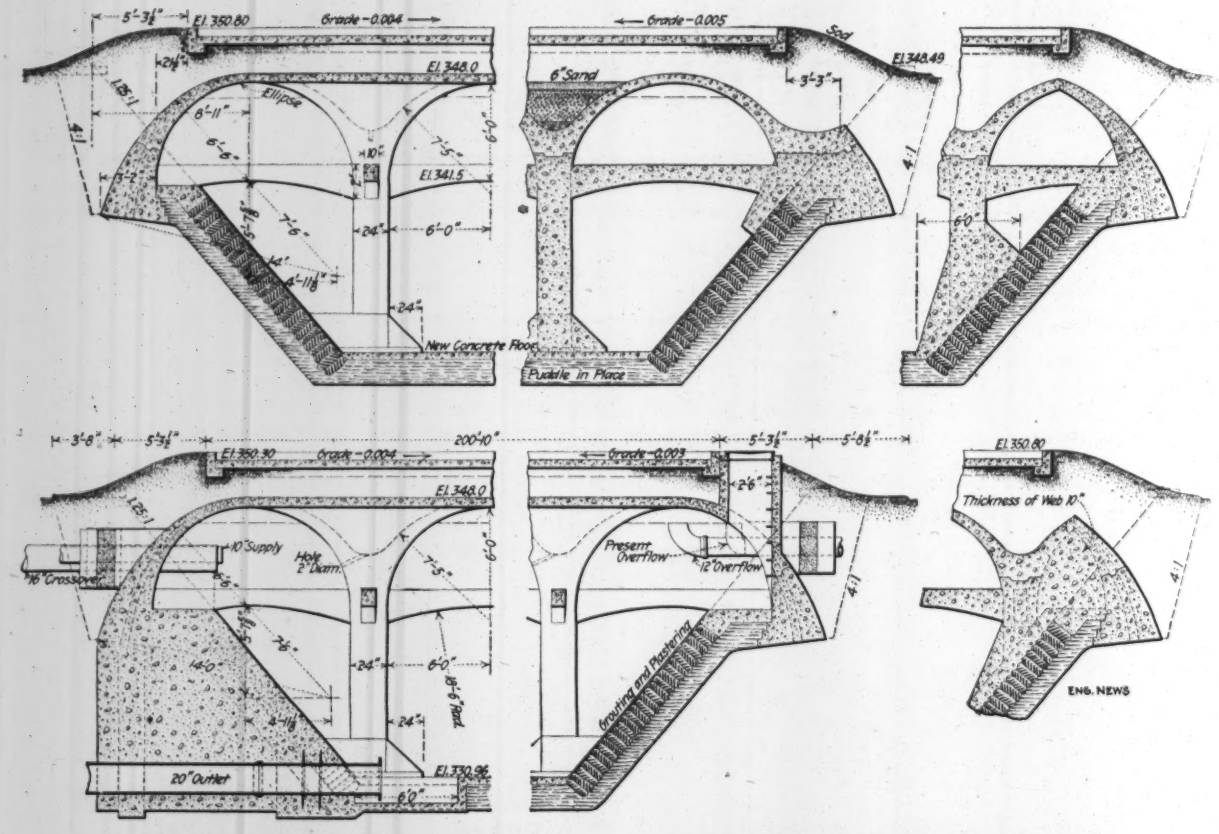


FIG. 2. DETAILS OF COVERING OF SOUTH BASIN, PENN ST. WATER-WORKS RESERVOIRS, READING, PENN.
(The covering was primarily to protect filtered water. Secondly, it provides an open-air municipal skating rink.)

The reservoir park is laid out with walks and flower beds of unique designs. Along these walks are benches. It might be of interest to note that roller skating is patronized almost exclusively by children, while ice skating is favored by old and young.

The only available cost data follow: Carpenter charges per cu.yd. of concrete, $1.38; lumber charges per cu.yd. of concrete, $1.04.

The rinks and covers for the reservoir were designed by and built under the direct supervision of Emil L. Nuebling, superintendent and engineer, Department of Water, Reading, Penn. The contractors were Fehr & O'Rourke, Reading, Penn. E. K. Cortright, Jr., was resident engineer on construction.

## The Search of the U. S. Geological Survey for Potash Deposits*

The U. S. Geological Survey has just issued a short report, by Hoyt S. Gale, on the progress of the work of deep drilling for potash, which is being carried on in the Carson Sink, near Fallon, Nev.

Last winter Congress appropriated $20,000 to enable the Geological Survey to prosecute a search for potash. An appropriation of $12,500 was also made to the Bureau of Soils for a like purpose.

Of the five possible general sources of potash [(1) igneous rocks, (2) marls, (3) alunite, (4) mineral saline deposits, and (5) organic sources, including wood ashes, beet-sugar molasses and residue, wool scourings and seaweed] the Survey is considering only one—saline deposits—and is devoting its appropriation largely to drilling for possible buried salts.

The first field work under the new appropriation was done in southern Wyoming, in the geologic formations termed the "Red Beds," which are known to be rich in salines, suggesting for many reasons the possibility of carrying deposits of the Stassfurt type. The data relating to the Wyoming salines were collected and reviewed and this work was followed by field examinations. The assumption of the existence of beds of potash salts in the Laramie Basin in southern Wyoming was logical, but the data at hand, which were fairly complete, proved to be chiefly of negative character.

Extension of the study of the Great Basin desert region revealed a promising area for the Survey's first drilling operations. The prehistoric Lakes Bonneville and Lahontan in a former geologic age were enormous bodies of water, many times the area of Lake Superior. In the reports of the early work of Messrs. G. K. Gilbert and I. C. Russell (Survey Monographs I and XI) are found detailed descriptions of the origin and structure of these old lake beds and from these investigations, made in the early eighties, it was concluded that the most promising test for the presence of buried saline deposits in concentrated form would be by drilling in the low portion of the Lahontan Basin.

A drilling outfit was shipped to the site and operations were begun on Oct. 1. On Nov. 18, a depth of 319 ft. had been reached, but up to then evidence of the geologic period of desiccation, in the form of crystallized beds of saline material, had not been found in the strata penetrated. It is expected that the drilling will be continued until a depth of at least 1000 ft. is reached. Mr. Gale's report also contains information with reference to the collection and tests of potash samples being carried on in cooperation between the U. S. Geological Survey, the Bureau of Soils and the department of geology of the Mackay School of Mines in Nevada, as well as an account of the activities of private enterprise in the search for potash.

*From information furnished by the U. S. Geological Survey, G. O. Smith, director.

# The Kansas City Municipal Wharf

By Clark R. Mandigo*

**The city of Kansas City, Mo., has recently put into service a municipally owned wharf and wharfhouse, equipped with modern freight-handling machinery. This is a novel idea in this country and the development of the enterprise and its effect on freight rates on the Missouri River will be watched with interest.**

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The navigation of the Missouri River as a commercial enterprise several times has gone through all the changes of bombast, ambitions, ideas, temporary success, blasted hopes and failure. The causes of the failures were not always the same, but the result has been that the railroads have never felt any serious competition from freight-carrying boats on the Missouri River. The rapid growth of Kansas City in the past decade, in population and industries, and its growing importance as a distributing center for that remarkably developing territory comprised in the States of Nebraska, Kansas, Oklahoma and Texas, has served to emphasize the heavy burden of freight rates imposed by the railroads on all territory west of the Mississippi.

The idea of a boat line which would really be a competitor in the freight business between St. Louis and Kansas City crystallized at a meeting of the Kansas City Commercial Club, on April 2, 1909, when a proposition for raising the required capital was submitted. It was to be a million-dollar boat line, or nothing. On March 1, 1910, the million-dollar mark was passed, and the boat line assured, although the books were not closed unitil $1,200,000 worth of stock had been subscribed by the business men of Kansas City as a working capital. At the same time, the question of adequate terminal facilities was agitated, and in the spring of 1910 the city voted in favor of a $75,000 bond issue to cover the cost of the construction of a wharf and wharfhouse. The problem of designing these improvements was turned over to the Engineering Department by the Board of Public Works early in 1911.

The only portion of the river front owned by the city and accessible to the railroads and wholesale district was near the site of the old wharf at the foot of Main St. The design of the wharf was taken up first, and after considering various form of masonry quay walls and timber structures, a creosoted pile and timber structure was decided upon as giving the greatest utility with the least cost.

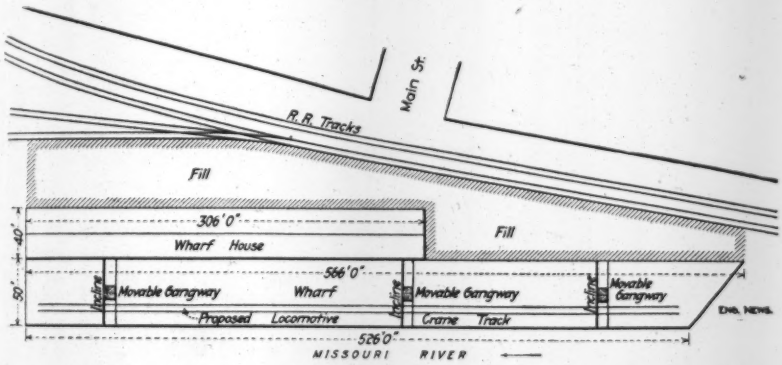



FIG. 1. GENERAL LAYOUT OF THE MUNICIPAL WHARF AT KANSAS CITY, MO.

## WHARF

The wharf is 50 ft. wide, 526 ft. long on the water side and 566 ft. long on the shore. It is built entirely of creosoted timber, resting on wooden piles driven to rock through the sloping river bottom. It is located some distance out in the river from the former shore line, immediately adjoining which run the tracks of the Missouri Pacific Ry., the intervening space being filled by the floor of the wharfhouse for some 300 ft. and by an earth fill for the remainder. The wharfhouse, now under construction, is entirely separate from the wharf proper, and is founded on concrete piles, as described below. Its floor and the earth fill back of it are on the same level as that of the wharf, but the earth fill back of the wharf proper was kept down to a level of 3½ ft. below the floor for the convenience of teams loading and unloading.

The design of the wharf proper is shown in Fig. 2. It consists of a series of pile bents, each bent capped by a 12×12-in. timber and well braced with cross bracing of 3×10-in. sticks. The bents are tied together by lines of longitudinal bracing and by the fenders. The six piles on each bent are placed 10 ft. c. to c., and the bents are 8 ft. c. to c., except where the three inclines, shown in Fig. 1, have been built to allow easy

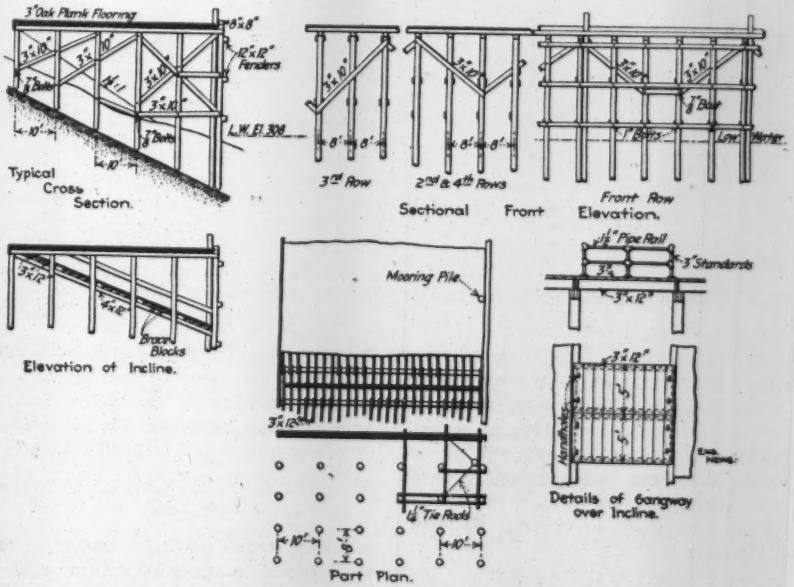



FIG. 2. DETAILS OF THE TIMBER WHARF CONSTRUCTION

access from the wharf to the boats during low water. Portable gangways (Fig. 2) have been built to cross these inclines on the floor level, so that there will be no impedance to the use of the floor area. The floor system is made up of 3×12-in. joists, 2 ft. c. to c., cross braced between supports and topped with a 3-in. oak plank. The upstream end of the wharf is sheathed to prevent the accumulation of ice packs or the drifting in of rubbish.

In addition to the ordinary lines of fenders along the water side, there is a floating fender the full length of the wharf, made up of several lengths of piling chained together. The ends only of this fender are fastened to the wharf piling by chains long enough to allow for extreme variations in the river stage. It has been very successful so far in keeping driftwood from lodging beneath the wharf. All the piling and timber used, except the floor planking and the cross bracing between the joists, was treated with 12 lb. of creosote oil to the cubic foot.

The river bottom at the wharf has been dredged to a depth of 32 ft. below the level of the wharf floor, which leaves about 6 ft. of water at extreme low water.

The contract for the construction of the wharf, including earth fill and some dredging in front, was let to the A. M. Blodgett Construction Co., April 10, 1911. The work was completed about Aug. 1, at a total cost of $22,760. The first boatload of freight to be brought up the river by the new boat line was handled over the wharf in June, by a temporary derrick, when the structure was about 75% completed.

In actual use, the wharf has proved very satisfactory. It remains to be seen what the effect of high water may be on the structure, but so far there has been no tendency to cut the bank. The utility of the inclines has been questioned, and the most that can be said of them is that they have not hindered the full use of the floor area for the handling of goods. They are also convenient for the landing of passengers at low stages of the river.

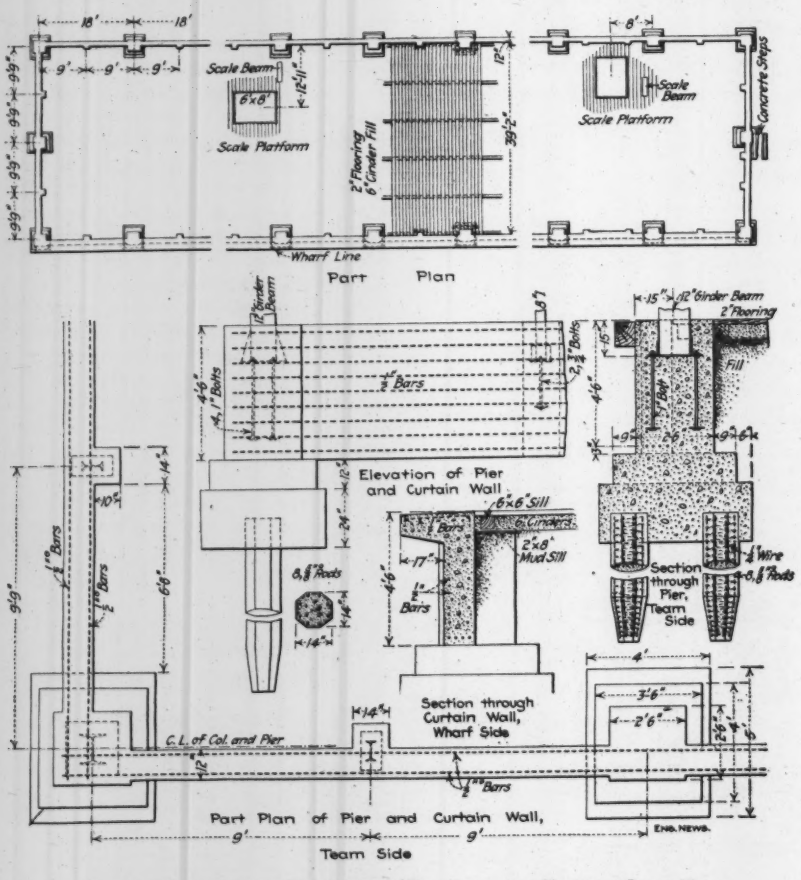



FIG. 3. FOUNDATION DETAILS OF WHARFHOUSE, KANSAS CITY, MO.

## WHARFHOUSE AND FREIGHT HANDLING SYSTEM

In connection with the design of the wharfhouse, a freight-handling system was worked out which, it is hoped, will materially reduce the cost of unloading and loading boats. On account of the short haul between Kansas City and St. Louis (operations will not be extended to the Mississippi for some time) the cost of getting the freight on and off the boat might be a large portion of the cost of transportation, especially if done by the common method of negro roustabouts and hand trucks. The freight rate on all classes of commodities by boat line is just 20% lower than by rail transportation, which makes a reduction in terminal charges all the more necessary. As little or nothing has been done toward an economical system of freight handling at river-boat terminals, there has been no precedent to go by, and the actual saving by the new system is not known.

The wharfhouse was located at the rear of the wharf, instead of near the face, for several reasons. In the first place, the full floor area of wharf can be utilized for temporary storage, and it also permitted the design of a permanent fireproof building of the proportion and hight other considerations demanded. A preliminary design for a reinforced-concrete structure was abandoned on account of the excessive cost, and a design work up along the general lines of a steel mill building.

The design of the wharfhouse is shown in Figs. 3 and 4. It is a structural steel framework, 306×40 ft. in plan, covered with metal lath and plaster and resting on a concrete base wall, which, in turn, rests on concrete piles driven into the river bottom. The base wall is of reinforced concrete, 1 ft.×4 ft. 6 in. in section, and rests on a series of concrete pedestals spaced 18 ft. c. to c., each one of which is built into the top of two concrete piles. The details are shown in Fig. 3. The floor of the house is of 2-in. plank, resting on cinders and mud sills on top of the earth fill. Expansion joints are provided on the long sides of the curtain wall, as shown in the figure.

On this wall, the steel framework is built, 12-in. girder beams forming the columns at the main pedestals and 8-in I-beams the columns at points half way between the pedestals. The framing of the superstructure has nothing in it of extraordinary interest. A canopy is provided on the wagon side for easy access to the house. The walls of the house are made of metal lathing, covered with plaster.

For the freight-handling system, two lines of runways for the operation of a three-ton capacity traveling hoist have been provided for the length of the building, suspended from the truss, as shown in Fig. 5. The hoist will run out 8 ft. over the wharf on a cantilever arm of the track near the two ends of the building. There will also be one line of track out the wagon side for handling heavy pieces of freight directly from the

wharf to wagons. The specifications for this conveyor are in part as follows:

Furnish and install a freight-handling system for wharfhouse consisting of one traveling hoist, runways, curves, switches, wiring and all necessary connections, supports, etc., to make a complete operative system as shown on the drawings and described in these specifications. The runway shall consist of the number and length of 15-in., 42-lb. steel I-beams shown on drawings, bent to a true uniform radius on curves and securely fastened to trusses or supports. Furnish and place all supporting beams, plates and connections shown or required, all joints to runway to come directly under supports only.

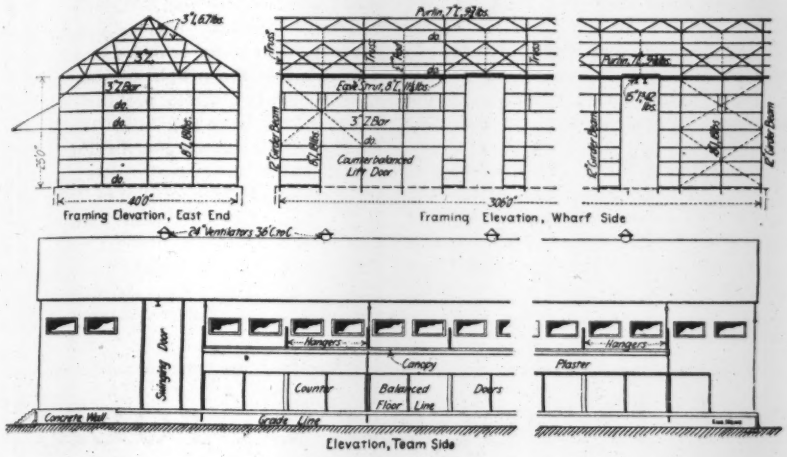


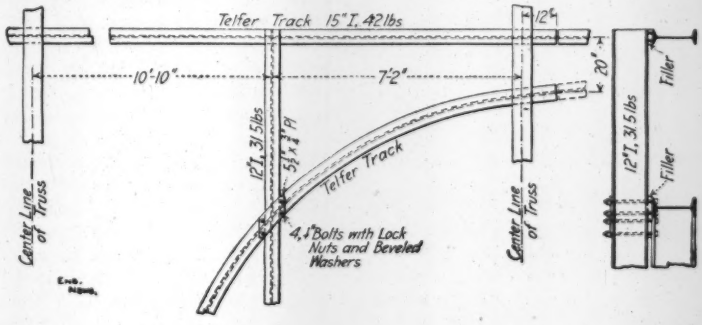

FIG. 4. DETAILS OF SUPERSTRUCTURE OF THE WHARFHOUSE

Furnish and install runway switches where shown on plans. Detail plans of switches showing all dimensions, connections, method of operation, etc., shall be submitted to the Board of Public Works for approval before being installed. Each switch shall be so arranged that it may be operated from the hoist or the floor of the wharfhouse from either direction. It shall be easy of operation and designed to take the loads which may come upon it.

The traveling hoist shall be a two-motor, cage-controlled, traveling electrical hoist, of a maximum lifting capacity of 6000 lb. Motors to operate on 220-volt direct-current circuit. The hoisting motor to be of such power and so geared as to give a hoisting speed of at least 25 ft. per min. under full load. The trolley motor shall be so geared and of such power as to give a traveling speed of not less than 250 ft. per min. when fully loaded, and not less than 300 ft. per min. when running light.

The hoist shall be so constructed as to operate successfully and with speed on runway shown on drawings and herein described and on a minimum radius of curvature of tracks of 10 ft. The hoisting mechanism shall be provided with a limit switch, which will automatically cut out the hoisting motor and clamp the hoisting drum at the extreme upward lift of the hook. The lifting hook shall have a clear lift between extreme positions of not less than 20 ft.

The cage shall be open, of substantial construction and shall contain encased controlling devices for the motors. It shall be large enough to comfortably seat one man.




Typical Detail of Framing

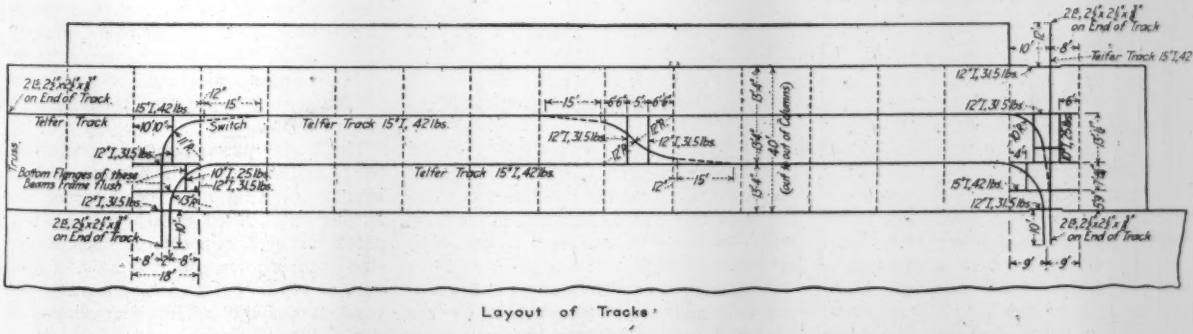



FIG. 5. LAYOUT AND DETAILS OF TELFER SYSTEM, MUNICIPAL WHARF, KANSAS CITY, MO.

Plans and specifications are being drawn for the installation of a locomotive jib crane, operating on a track extending the full length of the dock and located 15 ft. from the face. This crane will have a maximum radius of 35 ft., which will allow a swing of 20 ft. over the water and to the rear face of the wharf. With this arrangement, goods may be passed from the boat to the telfer or stacked on the wharf.

The telfer will pick up the goods from the wharf and deliver them in front of the proper door inside the house. At first the freight will all be handled in large hemp-rope nets, the separate packages being piled onto the net on board boat, the corners of the net clamped together, and the whole load handled as a unit. A further amplification of this method which is being worked out is to have each consignment of freight stored on board ship in one or more uniform package carriers, containing from 1000 to 2000 lb. of goods. These could be handled with dispatch and ease from the boat to the house, and need not be broken until they arrive at the warehouse of the consignee. This arrangement would save considerable expense in weighing, sorting and storing goods, with but little extra expense for equipment. It is expected that the wagon side of the wharfhouse will be used for incoming freight and the wharf side for outgoing freight, as this will be the most convenient in loading and unloading with the telfers. The switches on the runway for the telfer are arranged for convenience in routing the telfers and will not have to be thrown for each trip, even when two telfers are operating from the same doorway. A railway switch track will probably be installed along that portion of the rear face of the wharf not occupied by the building for the transferring of freight originating outside of Kansas City.

The contract for the construction of

the wharfhouse, including telfer runways and one telfer, was awarded to F. H. Crites, of Kansas City, on Oct. 16, 1911, for the sum of $29,376, with 120 days to complete the same. The use of two concrete piles under each pier with a reinforced-concrete curtain wall between to prevent unstable equillibrium, the selection of the fan type of Fink truss on account of the extra load coming at the panel points, the large number of lift doors to reduce trucking, and the design of the full-height doors, are practically the only unusual points in the design. The wood floor will be replaced with granitiod as soon as the fill beneath has attained its settlement.

The roadway must now be paved, and the locomotive crane and an electric lighting system installed. Two more telfers, scales, a partitioned office of some kind, storage battery trucks and a conveyor up one of the inclines are future possibilities. No more than was necessary for a thorough trial of the operation of the system selected has been included in present contracts. As defects or advantages appear under actual usage, the proposed equipment will be corrected or added to.

It remains to work out a system of charges, probably on a basis of tonnage handled, to cover the cost of wages of operators, running expenses and repairs and maintenance on the structures. As a municipal enterprise, the terminal must be open to all comers, nor is it advisable for other reasons to allow the operation of equipment to be undertaken by other than public servants. At the same time, fixing the basis of charges for the, as yet, irregular arrival of boat or barge loads of miscellaneous freight, is rather a knotty problem, especially with our present inadequate knowledge of costs. The spirit of the people of Kansas City in tackling the whole problem and the interest they have shown in its development should be much commended.

The entire construction was designed by the writer, in consultation with Mr. L. R. Ash, City Engineer. Mr. F. E. Gallop was draftsman for the plans, and Mr. R. E. Kiser, steel detailer and checker, all of the Department of the Board of Public Works of the city.

# Panama Canal Dredge "Corozal"

By Wm. G. Comber*

**Description and results of speed and endurance tests of the 1200-cu.yd. per hour ladder dredge just completed for the Isthmian Canal Commission.**

*Resident Engineer, Pacific Division, Panama Canal, Ancon, C. Z.

There was recently completed and tested for the Isthmian Canal Commission one of the largest ladder dredges in the world. This is the "Corozal," which will soon be at work on the Pacific end of the Panama Canal.

The tidal section of the Panama Canal on the Pacific side is to be 45 ft. in depth at mean tide. The maximum oscillation of tide is about 20 ft., so that a dredge to reach bottom at all times must be able to reach a maximum depth of 55 ft.

From borings and dredging in the bed of the canal from the upper (shore) end of the Balboa wharf, Sta. 2240, to Sta. 2117, a length of 12,300 ft., it was found that a plateau existed, composed of hard and soft rock, stiff boulder clays, and conglomerates of various kinds; all are very hard material for the small dredges now in use, and not to be handled by the sea-going suction dredge "Culebra." The surface of this hard material varies from 18 to 40 ft. below mean tide datum, probably making about 4,000,000 cu.yd. in all, which must be excavated.

After breaking up this surface by blasting or otherwise, it was thought that it could best be handled by a dipper or a ladder dredge; because of the great depth of the material a powerful ladder dredge was finally decided upon as the most economical. Accordingly, in the early part of the year 1910, bids were asked for the building and delivery at the port of Ancon, C. Z., of a twin-screw self-propelling hopper ladder dredge, which must be able to dredge 1200 cu.yd. of mud per hour, when dredging at a depth of 50 ft., and half that amount when dredging in boulder clay. Three bids were received as follows: Union Iron Works, San Francisco, Calif., $874,146; Lobnitz & Co., Renfrew, Scotland, $449,000, and Wm. Simon & Co., Renfrew, Scotland, $399,340. The Wm. Simon & Co.'s bid was accepted and the contract signed on Aug. 13, 1910.

The contract included the building, launching, fitting out complete, and testing of a self-propelling center ladder, combined hopper and barge-loading dredge. It was to be built of steel and provided with all boilers, main and auxiliary engines, and other machinery for propelling the vessel and dredging in mud, clay or soft rock. It was to be provided with dredge ladder, two sets of buckets, winches, boats, stores and all things necessary for its proper and efficient equipment. The contract also included the cost of carrying out speed trials, testing the dredge both by digging mud and clay, and the insurance and delivery of the vessel complete, in working order, to the Isthmian Canal Commission at Ancon.

A guarantee of all materials and workmanship and the maintenance of the dredge for a period of six months after its delivery to the Commission was agreed to by the contractor. After the expiration of this time a survey is to be made of the engines, tumbler-wheel shafts, and all parts of the dredge which are liable to excessive wear, and any part showing undue wear is to be renewed by the contractor at his expense.

The specifications provide that the dredge be capable of cutting its own flotation, and of dredging at a depth of 50 ft. below the light water line, when the ladder makes an angle of 45° with the vertical; at this angle the material handled is not to be less than 1200 cu.yd. per hour of sand or mud. The discharge is either direct into hoppers or to barges alongside. When loaded with 1200 tons of spoil in the hopper and 100 tons of bunker coal, in addition to all stores, boats, anchors, chains, etc., the dredge must be capable of steaming at the rate of 10 knots per hour.

The two sets of buckets required by the specifications are, one set with buckets of 54 cu.ft. capacity each, and one set with buckets of 34 cu.ft. each. The speed of dredging is not to exceed 18 buckets per min. in soft material and 14 per min. in hard material. The buckets are made with cast-steel backs and bodies of pressed plates of mild steel. The lips are of manganese steel forged to correct shape and afterward tempered. The combined hopper capacity is 27,500 cu.ft., including coamings. Suitable hydraulic gearing is provided for raising the hopper doors.

The motive-power plant consists of two steel cylindrical multi-tubular boilers, supplying steam at a pressure of 180 lb. per sq.in., fitted with Morrison corrugated furnaces, two sets of triple-expansion engines for working at a boiler pressure of 180 lb. per sq.in. and having independent surface condensers, circulating, air and feed pumps, and auxiliary engines for winches, dynamos, pumps, etc. Each boiler is large enough to insure a plentiful supply of steam for working at one time and at full speed one set of propelling or dredging engines, together with all winches, dynamos, pumps,

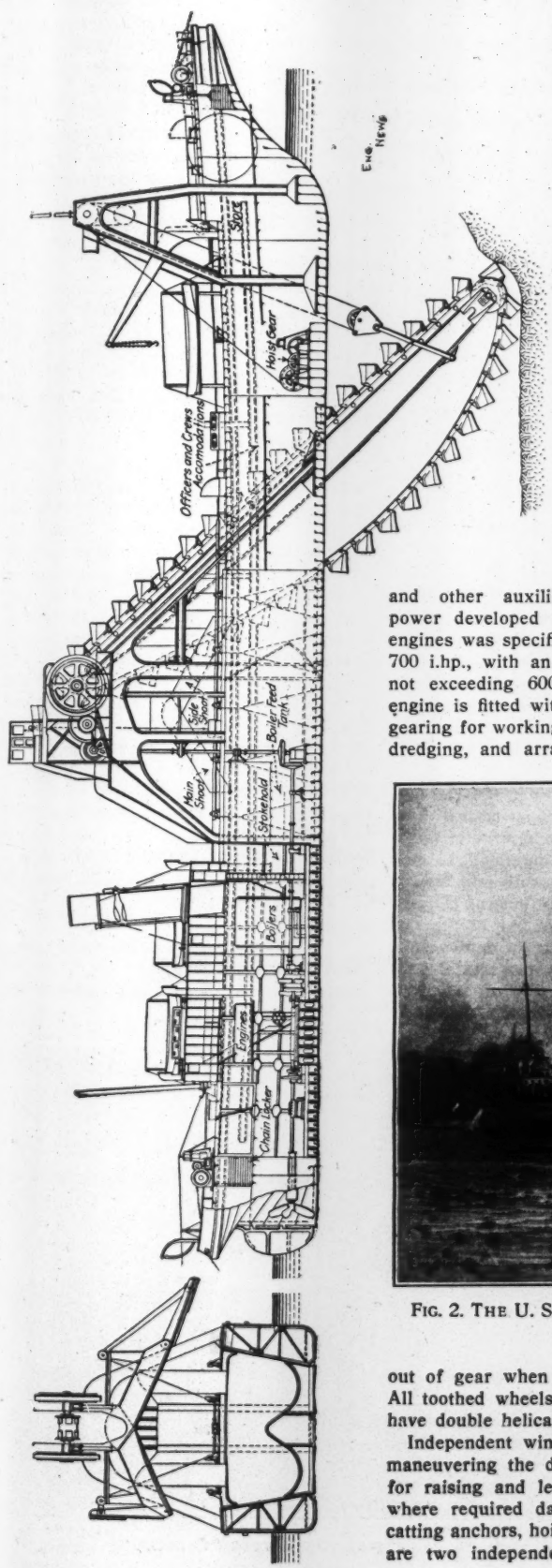



FIG. 1. GENERAL DRAWING OF THE U. S. PANAMA CANAL DREDGE "COROZAL"

and other auxiliary machinery. The power developed by each of the main engines was specified to be not less than 700 i.hp., with an average piston speed not exceeding 600 ft. per min. Each engine is fitted with friction and toothed gearing for working at three speeds when dredging, and arranged so as to throw out of gear when propelling the vessel. All toothed wheels are of cast steel and have double helical teeth.

Independent winches are provided for maneuvering the dredge while dredging, for raising and letting go anchors, and where required davits are provided for catting anchors, hoisting boats, etc. There are two independent combined engines and dynamos for generating electricity for lighting the ship above and below, each unit being of sufficient capacity to do all the electrical work of the dredge. Exhaust steam from all auxiliary engines is taken to condensers in the engine room, where provision is made that either condenser may be used for either main or auxiliary engines.

The counter of the dredge has sufficient overhang to completely house the propellers and rudder when the vessel is alongside a wall having a batter of 1 in 4.5. A bridge with navigating house is provided near the middle of the vessel, which contains a combined hand and steam steering gear, a binnacle compass and repeating telegraphs to the engine room. Repeating telegraphs from the ladder-hoisting winch, and from the forward and after winches, are also provided. The vessel is so constructed that tanks of about 15,000 gal. capacity, located on each side of the hopper, may be utilized for fuel oil if desired. These tanks are connected with the engine room by 2-in. pipes.

A cold-storage chamber containing a No. 3 Remington ice machine of from 5 to 6 tons capacity, with a complete outfit for the same, is provided in a convenient location. The complete outfit of all water and oil tanks, stores, boats, chains, ropes, lifebuoys, etc., required by the U. S. Board of Supervising Inspectors or Lloyds Survey for vessels classed 100 A1 is provided for in the contract.

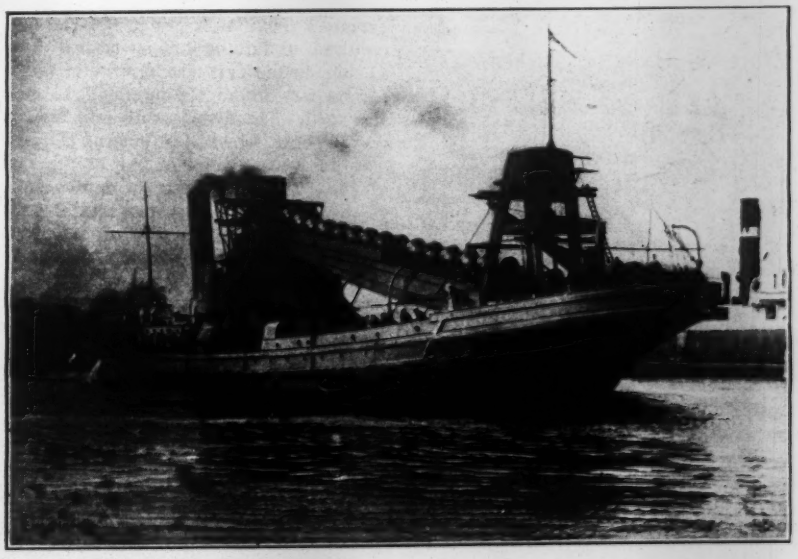


FIG. 2. THE U. S. PANAMA CANAL DREDGE "COROZAL," EQUIPPED WITH 54-CU.FT. BUCKETS

The delivery of the dredge complete was guaranteed by the contractor one year from the date of signing the contract, and a penalty of $150 per day was agreed upon for each day's delay after the expiration of this time, except in the case of certain contingencies. The con-

tractor was delayed several months by labor troubles and also a few days by the inspector's delay in arriving. It was, therefore, not until Sept. 12, 1911, that the "Corozal" was launched, with outfit with the exception of the propelling engines.

All parts of the dredge worked well. Table I gives a tabulated record of the three load tests. The dredged material

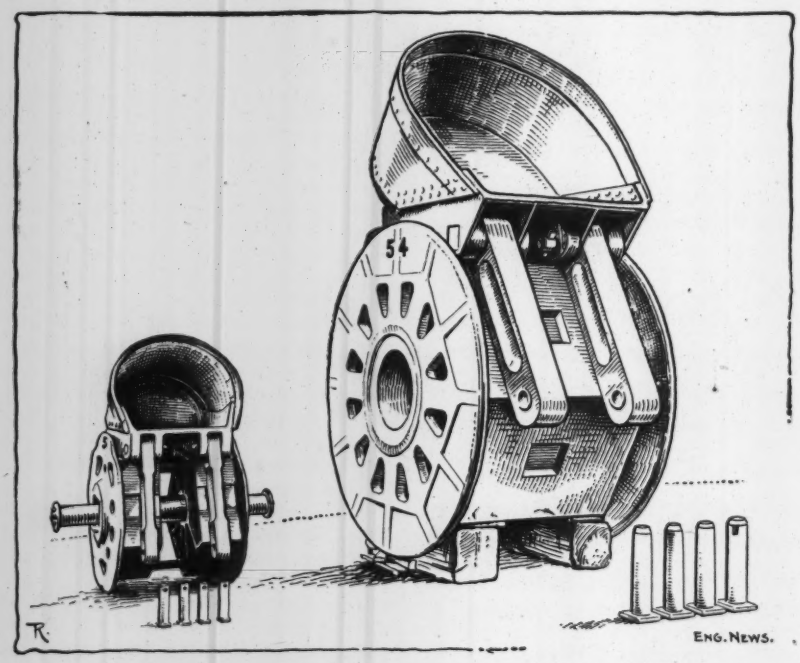



FIG. 3. COMPARATIVE SIZES OF A 5-CU.FT. AND A 54-CU.FT. BUCKET

steam up. Her dimensions are as follows:

| | | | |
|---|---|---|---|
| Length overall | | 268 ft. 9 in. | |
| Length between perpendiculars | | 259 ft. 0 in. | |
| Length load water line | | 239 ft. 0 in. | |
| Breadth molded | | 45 ft. 0 in. | |
| Depth | | 19 ft. 0 in. | |
| | Draft, light | Draft, loaded | |
| Fwd. | 12 ft. 0 in. | 14 ft. 3 in. | with 1200 tons spoil |
| Aft. | 14 ft. 4 in. | 17 ft. 4 in. | |
| Mean | 13 ft. 2 in. | 15 ft. 9½ in. | |

One month later the dredge was put through mud-dredging trials, speed tests, and a six-hour endurance run. The first dredging tests were unsatisfactory for the reason that the driving pinions, which run loose on gun-metal bushings, on the two driving-gear shafts, were too tight a fit, causing the bearings to become hot. A few days later the dredge was again tested on mud dredging for speed and endurance.

The dredge was fitted with the large buckets of 54 cu.ft. capacity, and had on board all stores, 100 tons of coal, boats, anchors and chains, with the exception of three head and three stern chains and anchors, which were in use for mooring purposes. During the first load the starboard engine driving the fast dredging gear was used. Steam was taken from the port boiler, and the starboard air pump and condenser, feed pump, filter and feed-water heater were kept in service. No difficulty was had in maintaining steam in one boiler during the dredging operations sufficient to run the entire

averaged about 92 lb. per cu.ft. The time required to fill the hopper varied from 41 min. in the first test to 53 min. in the second test where the intermediate gear was used. The fastest work was done in the first test, when 1114 tons of material was dredged in 41 min., or at the rate of 1482 cu.yd. per hour, at depths from 40 to 50 ft. During these trials the dredging gear ran smoothly without heating, and no difficulty was experienced in supplying steam from one boiler to the driving engine and all auxiliaries. Taking the average of the time required to fill the hopper the three times gives a rate of 1320 cu.yd. per hour at depths from 33 ft. 6 in. to 50 ft. 3 in.

Table II gives the results of the speed trials made in the Gareloch on Oct. 10, 1911. During these tests the propelling machinery was operated coupled to the extension dredging gear-driving shafts. The dredge had 1168 tons of spoil on board, 130 tons of coal and all stores, boats, anchors and chains, etc. The propelling engines ran smoothly and with practically no vibration. Condensers, air pump, boiler-feed pump, feed-water heater and filter were used, and all worked satisfactorily. The average speed of the three runs was 9.678 nautical miles per hour.

Table III gives the results of a six-hour endurance run made on a meandering course up and down the Firth of Clyde. During these trials, also, the dredge gear shafts were coupled to the propelling shaft. Throughout the test the donkey pump was in use, making an average of 15 double strokes per min.; the circulating pumps and engines, making an average speed of 200 r.p.m., air pumps operating at an average of 40 double strokes per min., and, during the last two hours of the test, one dynamo and driving engine at an average speed of 620 r.p.m., were run. No heating in any bearings of the propelling or dredging gear during the six-hour run was noticeable, and steam was maintained without difficulty. The hopper was empty and the draft forward was 13 ft., and aft 14 ft. 1 in., giving a mean draft of 13 ft. 6½ in.

The mud and speed trials noted were accepted as satisfactory by the Commission. The trial of dredging in clay was made in Belfast Harbor, where a suita-

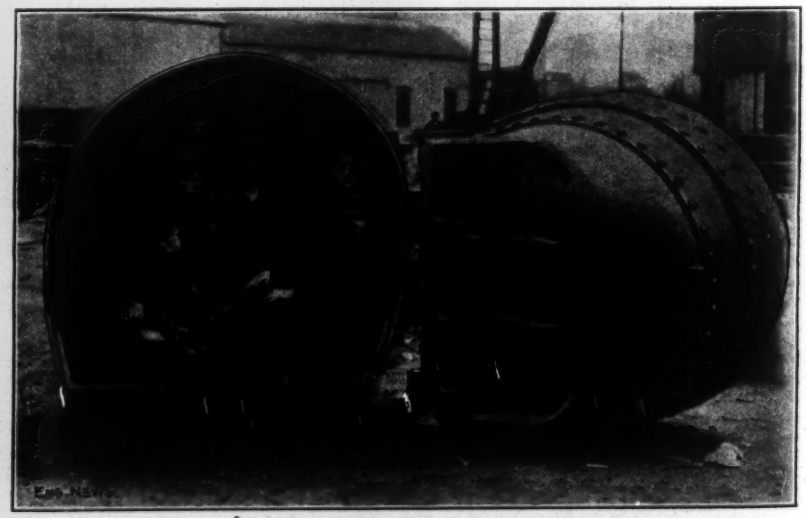


FIG. 4. A 54-CU.FT. BUCKET OF THE DREDGE "COROZAL"

TABLE I. TEST LOADS IN MUD

First Load

Starboard Engine. Port Boiler. Fast Gear. Oct. 14, 1911.

| Time | Stm. Prs. | Pres. in 1st Rec. | Pres. in 2d Rec. | Cond. Vacuum | Rev. Engine | Speed Bkts. per Min. | Depth Ladder | I.hp. |
|---|---|---|---|---|---|---|---|---|
| 9.56 | 152 | 28.0 | 3.5 | 17.0 | 114 | 17½ | 40 ft. 0 in. | |
| 10.01 | 152 | 26.0 | 1.5 | 18.0 | 130 | 20 | 41 ft. 0 in. | |
| 10.06 | 152 | 26.0 | 3.0 | 18.0 | 117 | 18 | 42 ft. 0 in. | |
| 10.11 | 152 | 30.0 | 5.5 | 18.3 | 115 | 18 | 45 ft. 6 in. | |
| 10.16 | 152 | 29.0 | 5.0 | 18.3 | 118 | 18¼ | 45 ft. 0 in. | 516.5 |
| 10.21 | 150 | 28.0 | 5.0 | 18.3 | 118 | 18¾ | 45 ft. 9 in. | |
| 10.26 | 150 | 28.0 | 5.0 | 18.5 | 112 | 17½ | 46 ft. 6 in. | |
| 10.31 | 150 | 29.0 | 4.5 | 18.5 | 115 | 18 | 50 ft. 0 in. | 527.7 |
| 10.36 | 150 | 28.0 | 3.5 | 19.0 | 109 | 15½ | 50 ft. 0 in. | |
| 10.37 | Hopper filled, dredging time, 41 min. | | | | | | 50 ft. 0 in. | |

Note—I.hp. as computed from cards.

Average weight 1 cu.ft. dredged material, 91.2 lb. dark mud, 1114 tons dredged in 41 min., or 1482 cu.yd. per hour at depths varying from 40 to 50 ft. Mean loaded draft, 16 ft.

Second Load

Starboard Engine. Port Boiler. Intermediate Gear. Oct. 14, 1911

| Time | Stm. Prs. | Pres. in 1st Rec. | Pres. in 2d Rec. | Cond. Vacuum | Rev. Engine | Speed Bkts. per Min. | Depth Ladder | I.hp. |
|---|---|---|---|---|---|---|---|---|
| 11.58 | 150 | 12.0 | 0.5 | 15.5 | 127 | 15½ | 33 ft. 6 in. | |
| 12.03 | 150 | 16.0 | 0.5 | 17.2 | 128 | 15½ | 36 ft 9 in. | 399.6 |
| 12.08 | 150 | 14.0 | —1.0 | 17.8 | 128 | 15½ | 38 ft. 0 in. | |
| 12.13 | 150 | 14.0 | —1.0 | 19.0 | 127 | 15½ | 40 ft. 0 in. | 417.3 |
| 12.18 | 150 | 18.0 | 0.5 | 19.5 | 130 | 15¾ | 42 ft. 0 in. | |
| 12.23 | 150 | 14.0 | 0.0 | 20.0 | 140 | 16¾ | 43 ft. 9 in. | |
| 12.28 | 150 | 13.0 | —0.5 | 20.5 | 130 | 15¾ | 44 ft. 9 in. | |
| 12.33 | 152 | 14.0 | 0.5 | 21.0 | 129 | 15½ | 50 ft. 0 in. | |
| 12.38 | 153 | 14.0 | 0.0 | 21.5 | 129 | 15½ | 48 ft. 0 in. | 416.2 |
| 12.43 | 152 | 15.0 | 0.0 | 21.7 | 130 | 15¾ | 50 ft. 3 in. | |
| 12.48 | 151 | 17.0 | 0.5 | 21.8 | 133 | 16 | 50 ft. 0 in. | |
| 12.51 | Hopper filled. Total time of dredging, 53 min. | | | | | | 50 ft. 0 in. | |

Note—I.hp. computed from cards.

Average weight 1 cu.ft. material, 91.1 lb. (6 boxes weighed). Dark mud, 1114 tons dredged in 53 min., or at the rate of 1148 cu.yd. per hour at depths varying from 33 ft. 6 in. to 50 ft. 3 in. Draft the same as at completion of first load.

Third Load

Port Engine. Starboard Boiler. Fast Gear. Oct. 14, 1911

| Time | Stm. Prs. | Pres. in 1st Rec. | Pres. in 2d Rec. | Cond. Vacuum | Rev. Engine | Speed Bkts. per Min. | Depth Ladder | I.hp. |
|---|---|---|---|---|---|---|---|---|
| 2.47 | 168 | 16.0 | —4.0 | 23.0 | 112 | 17½ | 34 ft. 0 in. | |
| 2.52 | 168 | 16.0 | —5.0 | 22.8 | 108 | 16¾ | 38 ft. 0 in. | |
| 2.57 | 167 | 14.0 | —5.0 | 22.5 | 111 | 17¼ | 39 ft. 9 in. | 467.0 |
| 3.02 | 165 | 15.0 | —5.5 | 33.6 | 110 | 17 | 41 ft. 6 in. | |
| 3.07 | 164 | 18.0 | —2.0 | 23.0 | 106 | 16½ | 44 ft. 9 in. | |
| 3.12 | 162 | 20.0 | 0.5 | 23.3 | 106 | 16½ | 47 ft. 0 in. | 499.9 |
| 3.17 | 162 | 19.0 | 0.0 | 23.5 | 105 | 16½ | 48 ft. 6 in. | |
| 3.22 | 160 | 14.0 | —1.5 | 43.2 | 101 | 15¾ | 49 ft. 0 in. | |
| 3.27 | 161 | 14.0 | —1.0 | 43.5 | 104 | 16 | 50 ft. 0 in. | 413.0 |
| 3.32 | 160 | 17.0 | 0.0 | 43.7 | 102 | 16 | 50 ft. 0 in. | |
| 3.34 | Hopper filled. Total time of dredging, 47 min. | | | | | | 50 ft. 3 in. | |

Note—I.hp. computed from cards.

Average weight 1 cu.ft. dredged material, 92.8 lb. (7 boxes weighed). Black mud, 1168 tons dredged in 47 min., or at the rate of 1332 cu.yd. per hour. Draft, 16 ft. 1½ in.

TABLE II. SPEED TEST

Speed runs over measured nautical mile. Gareloch, Oct. 16, 1911

| Time | Stm. Prs. | Stm. I.P. | Stm. L.P. | Con. Vac. | Eng. Rev. | Engine | Total I.hp. | Time of run Min. | Time of run Sec. | Knots per hour | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | First Run. | | | | | |
| 10.33 | 178 | 58.0 | 12.0 | 26.5 | 121 | Stb. | 965.0 | 6 | 10½ | 9.717 | with wind. |
| | 180 | 56.0 | 11.0 | 27.0 | 120 | Prt. | 928.0 | | | | |
| 10.49 | 178 | 59.0 | 13.0 | 26.0 | 121 | Stb. | 963.5 | 6 | 19½ | 9.486 | against wind. |
| | 180 | 56.0 | 11.0 | 26.5 | 120 | Prt. | 919.0 | | | | |
| | | | | | | Second Run. | | | | | |
| 11.04 | 180 | 59.0 | 13.0 | 26.0 | 121 | Stb. | 960.0 | 6 | 9½ | 9.743 | with wind. |
| | 180 | 58.0 | 11.5 | 26.5 | 120 | Prt. | 932.4 | | | | |
| 11.19 | 180 | 60.0 | 14.0 | 26.0 | 122 | Stb. | 1000.5 | 6 | 11 | 9.704 | against wind. |
| | 180 | 58.0 | 11.5 | 26.5 | 120 | Prt. | 938.7 | | | | |
| | | | | | | Third Run. | | | | | |
| 11.34 | 180 | 60.0 | 14.0 | 26.0 | 122 | Stb. | 1004.2 | 6 | 6½ | 9.822 | with wind. |
| | 180 | 59.0 | 12.0 | 26.0 | 120 | Prt. | 943.0 | | | | |
| 11.51 | 180 | 60.0 | 14.0 | 26.0 | 122 | Stb. | 987.0 | 6 | 15 | 9.600 | against wind. |
| | 180 | 59.0 | 12.0 | 26.0 | 121 | Prt. | 965.0 | | | | |

TABLE III. SIX-HOUR ENDURANCE TEST

| | Starboard Engine | | | | | | Port Engine | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | Stm. Prs. | Stm. I.P. | Stm. L.P. | Con. Vac. | Eng. Rev. | I.hp. | Stm. Prs. | Stm. I.P. | Stm. L.P. | Con. Vac. | Eng. Rev. | I.hp. | Total I.hp. |
| 1.30 | 172 | 52.0 | 11.5 | 26.5 | 119 | 931.5 | 175 | 51.0 | 10.5 | 27.0 | 118 | 900.5 | 1832.0 |
| 2.30 | 173 | 52.0 | 12.5 | 26.7 | 119 | 937.2 | 175 | 53.0 | 11.5 | 27.0 | 120 | 924.0 | 1861.2 |
| 3.30 | 172 | 53.0 | 12.5 | 24.6 | 118 | 928.0 | 173 | 54.0 | 11.5 | 24.5 | 116 | 887.0 | 1815.0 |
| 4.30 | 172 | 55.0 | 12.5 | 26.0 | 120 | 928.0 | 172 | 53.0 | 11.5 | 25.5 | 119 | 915.5 | 1843.5 |
| 5.30 | 171 | 56.0 | 12.7 | 26.0 | 120½ | 930.0 | 175 | 54.0 | 11.2 | 25.7 | 120 | 908.0 | 1838.0 |
| 6.30 | 162 | 52.0 | 11.5 | 25.5 | 117 | 873.5 | 166 | 52.0 | 10.5 | 25.0 | 116 | 847.0 | 1720.5 |

[For other tables see p. 148]

ble stiff clay was found to exist. The "Corozal" arrived there on Oct. 24, having been previously fitted with the 34-cu.ft. buckets. Owing to the difficulty of getting out moorings, dredging was not begun until three days later. The dumping grounds were 11½ miles distant, so but one load per day could be taken.

The first official load was taken on Nov. 3. During the dredging, samples of the clay were taken and measured in boxes of 1-cu.ft. capacity, to determine the weight density of the material; the time at which the samples were taken was noted, and the time factor considered in averaging the weight of spoil, as the formation of the clay varied considerably at different depths. The quantity of material in the hopper was determined by taking measurements from the top of the load to the molded deck-line at different points representing equal areas on the surface of the load; these soundings were averaged and used in connection with the hopper capacity scale diagram. Each load was checked by determining the weight of dredged material based on displacement of load and weight density of dredged material.

Table IV [p. 148] gives the results of the three tests loads in clay. The feed pump, filter and feed-water heater were kept in service during the trials. The weight of the material averaged 128, 127.8 and 133.3 lb. in the three cases, respectively. The dredging speeds averaged 528, 575 and 443 cu.yd. per hour, respectively. The average of the three loads gives by actual measurement, 515 cu.yd. per hour, or, determined by the displacement of the dredge, 523 cu.yd. per hour.

The formation of the bottom at the dredging site varied greatly. Hard stiff red clay was encountered at depths under 38 ft., which averaged 126 lb. per cu.ft. Boulder clay was encountered at depths from 38 to 43 ft., in which were gravel and stones varying in size from that of a walnut to a stone of a foot or more in diameter. The weight of the boulder clay averaged about 135 lb. per cu.ft. At depths from 43 to 48 ft. a conglomerate mass of gravel and small stones mixed with boulder clay such as found above was encountered. Below a depth of 48 ft. a hard compact red sand was encountered, in which were stones and gravel, weighing about 141 lb. per cu.ft.; and it was very difficult material for the dredge to handle.

While dredging in the boulder clay before reaching sandy material, the buckets were well filled, and the dredge appeared to handle the material very well. During the last load the engine stalled repeatedly without showing any undue strain on the dredging machinery. All the dredging gears and bearings worked well with the exception of the forward bearing of the port driving-gear shaft in the engine room, which heated slightly, requiring water service on it to be kept in use.

The depths given in all the tables were taken from a quadrant indicator erected on deck, the scale being referred to the light water line, so that the actual depth of dredging referred to the water surface may be considered somewhat greater owing to the increase in draft of the dredge as loading progressed. Thus in the last load a dredging depth below the water surface of 53 ft. 2 in. was reached.

A general drawing of the dredge "Corozal" is shown in Fig. 1 and a photograph taken soon after launching in Fig. 2. Fig. 3 shows the comparative size of a 5-cu.ft. and a 54-cu.ft. bucket, and Fig. 4 one of the 54-cu.ft. buckets of the "Corozal."

**A Life of 23 Years** for a steam road roller is claimed by the Erie Machine Shops, of Erie, Penn. A catalog recently issued by this company states that the first Erie roller, built in 1889, is still in active service.

TABLE IV. TEST LOADS IN CLAY

Starboard Engine and Boiler. Slow Gear. Nov. 3, 1911

| Time A.M. | Stm. Prs. | Pres. in 1st Rec. | Pres. in 2d Rec. | Cond. Vacuum | Rev. Engine | Speed Bkts. per Min. | Depth Ladder | I.hp. |
|---|---|---|---|---|---|---|---|---|
| 7.26 | 165 | 9.0 | —2.0 | 18.0 | 130 | 13¼ | 30 ft. 3 in. | |
| 7.31 | 160 | 8.0 | 0.5 | 20.5 | 125 | 12⅞ | 31 ft. 6 in. | 420.7 |
| 7.36 | 163 | 9.0 | 0.5 | 21.0 | 124 | 12½ | 32 ft. 9 in. | |
| 7.41 | 160 | 8.0 | 0.5 | 23.0 | 128 | 13 | 34 ft. 3 in. | |
| 7.46 | 168 | 8.0 | —2.5 | 24.0 | 120 | 12¼ | 36 ft. 3 in. | |
| 7.51 | 174 | 7.5 | —4.0 | 24.5 | 123 | 12½ | 37 ft. 0 in. | 419.6 |
| 7.56 | 172 | 8.0 | —2.0 | 24.5 | 111 | 11¼ | 37 ft. 0 in. | |
| 8.01 | 163 | 8.0 | —4.0 | 24.5 | 110 | 11¼ | 37 ft. 9 in. | |
| 8.06 | 163 | 8.0 | 0.5 | 24.0 | 117 | 11¾ | 38 ft. 6 in. | |
| 8.11 | 160 | 7.0 | 0.5 | 23.5 | 122 | 12¼ | 39 ft. 3 in. | 550.2 |
| 8.16 | 160 | 7.5 | 0.5 | 24.0 | 128 | 13 | 40 ft. 1 in. | |
| 8.21 | 155 | 7.0 | 1.0 | 23.5 | 132 | 13¼ | 40 ft. 1 in. | |
| 8.26 | 154 | 8.0 | 1.5 | 23.0 | 131 | 13¼ | 40 ft. 6 in. | |
| 8.31 | 152 | 8.0 | 1.5 | 23.0 | 130 | 13¼ | 41 ft. 0 in. | 450.2 |
| 8.36 | 154 | 7.5 | 1.5 | 23.0 | 130 | 13¼ | 41 ft. 6 in. | |

Stopped at 8.36. Total time of dredging, 70 min.

Second Load.

Port Engine and Boiler. Slow Gear. Nov. 4, 1911

| Time A.M. | Stm. Prs. | Pres. in 1st Rec. | Pres. in 2d Rec. | Cond. Vacuum | Rev. Engine | Speed Bkts. per Min. | Depth Ladder | I.hp. |
|---|---|---|---|---|---|---|---|---|
| 7.22 | 163 | 9.0 | —7.0 | 20.5 | 122 | 12¼ | 28 ft. 6 in. | |
| 7.27 | 162 | 11.0 | —7.5 | 20.8 | 116 | 11¾ | 29 ft. 8 in. | |
| 7.32 | 160 | 12.0 | —6.0 | 22.5 | 125 | 12⅝ | 31 ft. 6 in. | 373.1 |
| 7.37 | 166 | 11.0 | —7.0 | 22.7 | 128 | 13 | 32 ft. 9 in. | |
| 7.42 | 176 | 10.0 | —7.5 | 23.0 | 124 | 12½ | 34 ft. 2 in. | |
| 7.47 | 177 | 12.0 | —4.0 | 23.0 | 125 | 12⅝ | 35 ft. 6 in. | |
| 7.52 | 164 | 8.0 | —7.0 | 23.0 | 130 | 13¼ | 36 ft. 6 in. | 389.5 |
| 7.57 | 164 | 8.0 | —7.5 | 23.4 | 128 | 13 | 37 ft. 9 in. | |
| 7.58 | Stopped for 2 minutes to clear log from bucket. | | | | | | | |
| 8.00 | 164 | 12.0 | —4.0 | 22.8 | 121 | 12¼ | 39 ft. 2 in. | |
| 8.05 | 158 | 13.0 | —2.5 | 23.0 | 127 | 12¾ | 39 ft. 2 in. | |
| 8.09 | Stopped for 4 minutes. Stb. side shoot choked. | | | | | | | |
| 8.13 | 174 | 12.0 | —5.0 | 22.5 | 127 | 12¾ | 39 ft. 2 in. | 512.5 |
| 8.18 | 165 | 12.0 | —6.0 | 23.0 | 124 | 12½ | 40 ft. 0 in. | |
| 8.23 | 166 | 12.0 | —4.0 | 23.0 | 133 | 13⅓ | 40 ft. 3 in. | |
| 8.28 | 160 | 13.0 | —4.0 | 23.0 | 126 | 12¾ | 40 ft. 3 in. | |
| 8.33 | 159 | 10.0 | —5.0 | 23.1 | 131 | 13¼ | 41 ft. 0 in. | 423.7 |
| 8.38 | 152 | 13.0 | —2.5 | 23.2 | 127 | 12¾ | 41 ft. 6 in. | |
| 8.41 | Engine stalled at 8.17 | | | | | | 41 ft. 6 in. | |

Stopped at 8.41. Total time of dredging, 73 min.

Third Load.

Port Engine and Boiler. Intermediate Gear. Nov. 8, 1911

| Time A.M. | Stm. Prs. | Pres. in 1st Rec. | Pres. in 2d Rec. | Cond. Vacuum | Rev. Engine | Speed Bkts. per Min. | Depth Ladder | I.hp. |
|---|---|---|---|---|---|---|---|---|
| 9.31 | 135 | 12.0 | —2.0 | 20.0 | 115 | 14 | 32 ft. 0 in. | |
| 9.36 | 130 | 17.0 | —2.0 | 20.0 | 114 | 13¾ | 33 ft. 9 in. | |
| 9.41 | 130 | 17.0 | —1.0 | 20.0 | 116 | 14 | 35 ft. 6 in. | |
| 9.46 | 135 | 16.0 | —0.5 | 19.5 | 114 | 13¾ | 37 ft. 6 in. | 468.7 |
| 9.47 | Stopped for 1 minute. Shoot choked. | | | | | | | |
| 9.51 | 133 | 16.0 | 0.0 | 20.0 | 115 | 14 | 38 ft. 3 in. | |
| 9.56 | 132 | 20.0 | 1.5 | 18.2 | 112 | 13½ | 39 ft. 2 in. | |
| 10.01 | 123 | 24.0 | 2.0 | 19.0 | 106 | 12¾ | 40 ft. 2 in. | 497.2 |
| 10.06 | 120 | 28.0 | 3.0 | 18.5 | 112 | 13½ | 41 ft. 2 in. | |
| 10.11 | 120 | 20.0 | 2.0 | 19.0 | 113 | 13⅝ | 42 ft. 2 in. | |
| 10.16 | 120 | 21.0 | 2.0 | 19.5 | 115 | 14 | 43 ft. 2 in. | |
| 10.21 | 120 | 25.0 | 3.5 | 19.0 | 115 | 14 | 44 ft. 0 in. | 455.7 |
| 10.26 | 122 | 26.0 | 3.5 | 19.0 | 118 | 14¼ | 45 ft. 0 in. | |
| 10.31 | 120 | 24.0 | 3.5 | 19.5 | 110 | 13¾ | 46 ft. 10 in. | |
| 10.36 | 120 | 18.0 | 3.0 | 19.5 | 118 | 14½ | 47 ft. 10 in. | |
| 10.41 | 122 | 20.0 | 3.0 | 19.5 | 112 | 13½ | 48 ft. 6 in. | 509.7 |
| 10.46 | 124 | 19.0 | 3.0 | 19.5 | 114 | 14 | 50 ft. 6 in. | |

Engine stalled at 10.11, 10.18, 10.26, 10.29, 10.33 and 10.36.
Stopped at 10.46. Total time of dredging, 74 min.

## A British Military Aeroplane Competition

The British War Office has offered the following prizes for aëroplanes particularly adapted to military service:

(1) Open to the World.

| | |
|---|---|
| First Prize | $20,000 |
| Second Prize | 10,000 |

(2) Open to British Subjects Only: For machines made wholly in Great Britain (except engines).

| | |
|---|---|
| First Prize | $7,500 |
| Two Second Prizes (each) | 5,000 |
| Three Third Prizes (each) | 1,500 |

The War Office limits the prizes which can go to any one competitor to $25,000, and reserves the right to regulate the totals to be awarded under groups (1) and (2) in accordance with the merits of the machines or to withhold all awards. The War Office has an option for the purchase of any prize winner for $5000. Oil and fuel will be supplied free during the tests. The owners of 10 machines submitted to all flying tests, but not securing prizes, will receive $500 per machine.

The following specifications as issued by the War Office (printed in London *Engineering*, Dec. 22, 1911) are interesting:

(1) Be delivered in a packing case suitable for transport by rail, and not exceeding 32x9x9 ft. The case must be fitted with eye-bolts to facilitate handling.

(2) Carry a live load of 350 lb. in addition to its equipment of instruments, etc., with fuel and oil for 4½ hours.

(3) Fly for three hours loaded as in Clause 2, and maintain an altitude of 4500 ft. for one hour, the first 1000 ft. being attained at the rate of 200 ft. a minute, although a rate of rise of 300 ft. per minute is desirable.

(4) Attain a speed of not less than 55 miles per hour in a calm (loaded as in Clause 2).

(5) Plane down to the ground in a calm from not more than 1000 ft. with engine stopped, during which time a horizontal distance of not less than 6000 ft. must be traversed before touching.

(6) Rise without damage from long grass, clover, or harrowed land in 100 yd. in a calm, loaded as in Clause 2.

(7) Land without damage on any cultivated ground, including rough plough, in a calm, loaded as in Clause 2, and pull up within 75 yd. of the point at which it first touches the ground when landing on smooth turf in a calm. It must be capable of being steered when running slowly on the ground.

(8) Be capable of change from flying trim to road-transport trim, and travel either on its own wheels or on a trolley on the road; width not to exceed 10 ft.

(9) Provide accommodation for a pilot and observer, and the controls must be capable of use either by pilot or observer.

(10) The pilot and observer's view of the country below them to front and flanks must be as open as possible, and they should be shielded from the wind, and able to communicate with one another.

(11) All parts of aëroplane must be strictly interchangeable, like parts with one another and with spares from stock.

(12) The maker shall accurately supply the following particulars, which will be verified by official test:

(a) The horsepower and the speed given on the bench by the engine in a 6-hr. run.

(b) The engine weight, complete (general arrangement drawing), and whether air or water-cooled.

(c) The intended flying speed.

(d) The gliding angle.

(e) Weight of entire machine.

(f) Fuel consumption per hour at declared horsepower.

(g) Oil consumption per hour at declared horsepower.

(h) Capacity of tanks.

(13) The engine must be capable of being started up by the pilot alone.

(14) Other desirable attributes are:

(a) Stand still with engine running without being held. Engine preferably capable of being started from on board.

(b) Effective silencer fitted to engine.

(c) Strain on pilot as small as possible.

(d) Flexibility of speed; to allow of landings and observations being made at slow speeds if required, while reserving a high acceleration for work in strong winds.

(e) Good glider with a wide range of safe angles of descent, to allow of choice of landing places in case of engine failure.

(f) It is desirable that the time and number of men required for the change from flying trim to road trim, or packed for transport by rail, and vice versa, should be small, and these will be considered in judging the machine. The time for changing from road trim and packed condition to flying trim to include up to the moment of leaving the ground in flight, allowance being made for difficulty in starting engine.

(g) Stability and suitability for use in bad weather and in a wind averaging 25 miles per hour 30 ft. from the ground without undue risk to the pilot. Stability in flight is of great importance.

(h) The packing case for rail transport to be easily dismantled and assembled for use, and when dismantled should occupy a small space for storage.

# A Cycle of Dry Years: 1909-1911*

By Allen Hazen†

From a physical standpoint, the year 1911 was an interesting one, as the third in a cycle of dry years. The first part of the year was particularly dry, and following two dry years, the deficiency in rainfall brought about conditions that were serious in many water-supply systems, especially where the catchment areas were small for the reservoir capacities.

This dry period, which now fortunately seems to have passed, has been one of the most notable that has occurred in New England since accurate records have been available.

One of the most important events of the year was appointing a committee by the association, to collect data as to this and other dry periods, and to study the whole subject. This committee is not yet ready to report, but it is believed that information will be obtained, which will serve for many years as a basis for estimating the capacity of water-supplies in New England.

It is nearly 30 years since there has been a record-breaking drought, and in this interval, the records of the Sudbury River, and a few other streams in the years following 1880, have been used as a basis for nearly all such calculations.

There is some reason for believing that earlier in the nineteenth century there was a drier period than that of the eighties, but records are inadequate.

When this report is available, it may be appropriate for the association to discuss the question as to how far a practical rating of water sources should be based upon the records of the driest year on record. Dry years may be classified according to the frequency with which they recur. There is a degree of dryness that is reached on an average once in 10 years, and another reached on an average once in 30 years, the latter represented approximately by the dry period of the early eighties, and again by the dry period of the last few years. Presumably, there will be still drier years, which may be referred to in a general way as occurring not oftener than once in a century.

On the other hand, a water-supply system is seldom drawn to its ultimate capacity, and in fact can be but seldom so drawn with safety, because the consumption is always fluctuating, and enough water must be on hand to cover fluctuations and reasonable increases in rate, and in order to do this, there is ordinarily some surplus capacity.

It may be questioned if it is justifiable, as a practical business proposition, to rate supplies on the droughts that only occur once in a century, or even on those which occur only once in 30 years, and whether it would not be better to take some less extreme basis, which basis could be established by proper records, and the limitations of which should be frankly recognized by writing them into all descriptions, and into the headings of tables.

For a city to be out of water is serious business. To be a little short one year in thirty may not be an intolerable condition, and it may be better business to have this happen, than to build a whole water-works system so large that its capacity may only be needed once in 30 years.

Let us say, for example, that we will take some shorter period as a basis, such as 10 years, and calculate the amount of water which can be certainly supplied 9 years out of 10, and on an average in the tenth year, and take our chance on being a little short once in 20 or 30 years, if it so happens that the full rated capacity would be then used if it were available.

Following out this idea and developing it somewhat, it might be stated that a certain water-supply was good for so many gallons per day four years out of five, for so many in 9 years out of 10, and for so many in 29 years out of 30. Each figure for capacity in this series would be somewhat smaller than the preceding one, and the ratios between them could be fixed with a fair degree of accuracy. We should then have a better idea of what chances we were taking, and what rating it was wisest to adopt.

*A small portion of the presidential address before the New England Water-Works Association, delivered at Boston, Jan. 10, 1911. Another part of this address, on "The Management of Water-Works," appeared in our issue of Jan. 17, 1912. The complete address will be printed in the "Journal" of the Association.

†Consulting Engineer, 103 Park Ave., New York City.

# Electrolysis of Pipes in Chicago

On Nov. 30, 1911, the Chicago City Council received the report of Mr. Ray Palmer, who had been retained as consulting engineer, to study the danger of electrolytic destruction of buried pipes and other subsurface work. Mr. Palmer's report has now been printed and the following information on the Chicago situation is taken from it:

Considerable areas about the several feeding substations of the street, elevated and tunnel railway companies were found to have a positive potential existing between the pipe line, and other buried structures, and the rails. Few examinations for damaged pipes were made, but these gave positive evidence of damage.

It was found that a great part of the current which was flowing from rails to pipes and from pipes to ground near the feeding substations was due to insufficient and defective return circuits of the companies mentioned. Although much work has been done by the railway and tunnel companies to improve their track circuits by better bonding, joint welding and return cables, yet they have not eliminated the dangerous conditions found in the vicinity of each feeding substation, at most river crossings and in steel-frame buildings.

An amendment was recommended to the present city ordinances which permit a potential drop in the return-conductor system of the railway company of 25 volts. Mr. Palmer recommended that the ordinance should provide for a maximum drop of 12 volts between any two points of the return-conductor system. He recommended also that the ordinance should compel the railway companies to install a return-conductor system to each feeding point, which should be equal to, or better than, a system connecting the various endangered structures with the switchboard of the feeding station and capable of carrying about 10% of output of the power apparatus of that station.

It was reported that, after the railways had reconstructed all defective track work and installed additional track feeders, a "pipe-line drainage system" could be installed to reduce to a practical minimum the damage being done. The drainage system proposed consists essentially of a number of insulated conductors, connected to positive points of the piping and of other buried systems and leading to the feeding negative busbars of that particular district. Drawbridges were to have return-circuit bypasses so that voltage conditions were not to be appreciably different with bridges open or closed.

It was also recommended that the city should coöperate at once with the railway companies to complete the survey of the electrolysis situation and to develop comprehensive plans for the necessary work.

A steel-frame building at the northwest corner of Madison St. and Wabash Ave. was tested for presence of stray currents flowing from the steelwork to ground. An 8-in. water pipe in the engine room was found to be carrying over 40 amperes out of the building on the Wabash Ave. side. A telephone cable sheath was also found to be carrying some current into the building from the tunnel company's system. A difference of potential of four volts was found between the steelwork of the building and the tunnel company's rails nearby.

It was believed that after the defects in the surface, elevated and tunnel railway-return circuits had been repaired, structural-steel buildings affected like this one could be protected by inserting high-resistance pipe joints in pipes where they enter the building, and by connecting all the entering pipe lines with insulated cables and by thoroughly connecting the structural-steel work to a good ground.

# 130-Ton Steam Shovel for Rock Work

**The increasing use of steam shovels for handling blasted rock during the past ten years has resulted in the building of heavier and heavier shovels for this work. During this period, the weight of the heaviest shovels has increased from about 90 tons to nearly 140 tons.**

**The construction of the shovel here described is marked by the extensive use of heavy steel castings for parts usually built up of structural steel. Steel castings are used for the front end of car body, the swing circle, bolsters and trucks.**

**A long-barrel locomotive boiler is used—58 in. diameter, 18 ft. 3 in. long. It is claimed to be from 15% to 20% more efficient than the ordinary short boilers.**

Since the steam shovel came into general use for handling blasted rock, some ten years ago, there has been going on a gradual strengthening and adaptation of steam-shovel designs to meet the severe requirements of this class of work. In 1904, a 95-ton shovel was considered a very heavy machine, while in more recent years the maximum weight has risen to about 110 tons. A design brought out during the past year by the Bucyrus Co., of South Milwaukee, Wis., and shown in the accompanying illustrations, has a total weight, in working condition, of about 130 tons; and a 137-ton shovel is made by the Marion Steam Shovel Co., of Marion, Ohio. The increase in weight has been due not so much to the use of larger dippers or more powerful engines as to the strengthening of the entire construction—dipper handle, boom and car body—to withstand the shocks and the racking stresses encountered in handling stone.

Some idea of the size and heavy construction of the Bucyrus shovel can be gained from the accompanying photograph and assembly drawing (Figs. 1 and 2). Its chief distinguishing feature is the use of heavy steel castings to replace structural-steel work at the front end of the car body and in the swing circle and trucks, but some description will be given of other points in its design, some of which are typical, in a measure, of modern heavy steam-shovel construction.

*From information supplied by G. B. Massey, 2d., Resident Engineer, the Bucyrus Co., 50 Church St., New York City.

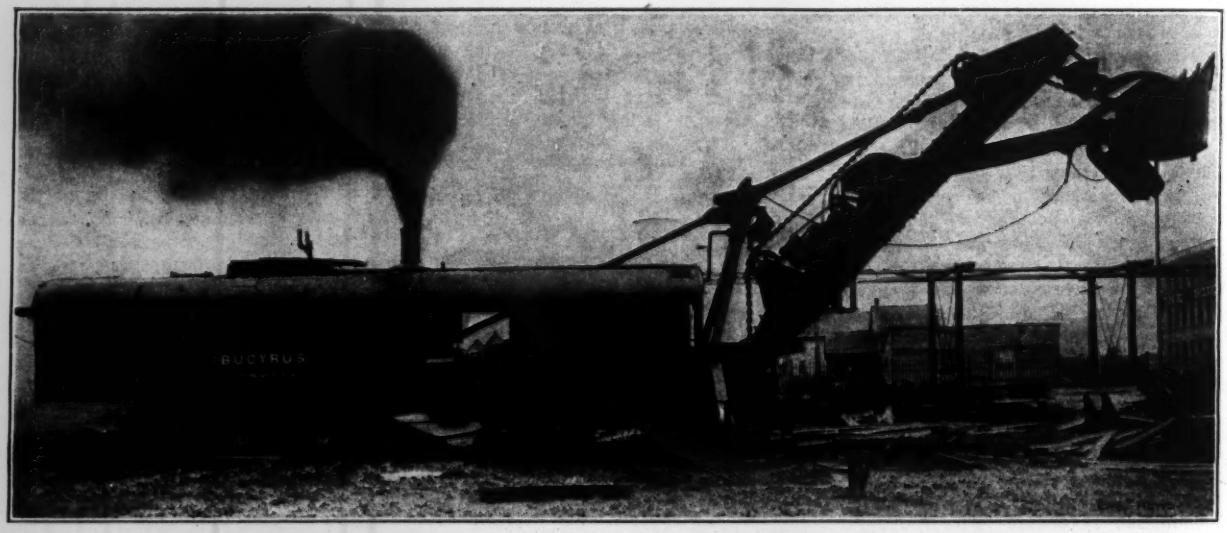



FIG. 1. 130-TON BUCYRUS STEAM SHOVEL

In the dipper handle, the construction has been made to follow that developed for the 110-ton shovel, but has been modified with a view to giving a still better combination of elasticity and strength. For a time, when 90- to 100-ton shovels were first built, structural-steel dipper handles were tried; but these were in many cases found to have too little elasticity, so that in subsequent shovels there was a return to the earlier type of armored-wood construction, modified to meet the requirements of the heavi- work. The handle of the 130-ton Bu- rus shovel consists of two 6x14-in. oa- timbers each encased by steel plates o- the sides and by heavier plates or bars a- the edges. The two main timbers ar- held apart at the dipper end by a thir- timber, of about the same section, place- between them as a spacing block. This block extends from the dipper end along the handle for about one-third its length.

The handle is maintained at the proper distance from the shipper shaft by the usual yoke-block and U-bolt arrangement. Two U-bolts, side by side, encircle bushings on the shaft and hold at their threaded ends a slide-plate which bears against the forward edge of the dipper handle. On the other edge of the handle, one bolted to each timber, are the racks, of manganese steel, which mesh with the manganese-steel pinions on the shipper shaft. Both racks and pinions are heavily shrouded to the pitch line.

On the Bucyrus shovel, as shown in the sectional view in Fig. 2, the heads of the bolts that hold the racks in place are sheltered in countersunk holes in an additional pair of steel bars riveted to the reinforcing bars on the upper side of the dipper handle. This construction permits the use of a slide-plate having a bearing surface over the full width of the handle. In some makes of shovels, the bolt heads or nuts are left projecting above the handle, but the slide-plate is grooved to allow it to pass over the bolts without touching them.

The boom, like the dipper handle, is of composite wood and steel construction. It consists of two built-up oak timbers, each about 7x28 in. in section and each

armored with ¼-in. steel plates on the sides and with heavy bars, 7 in. wide by 1½ in. thick along the edges. The timbers are further reinforced on the sides by steel straps near both top and bottom edges. Spacing blocks are used between the two members of the boom at the lower end and as far up as the shipper shaft, near which the blocks are placed along a diagonal line, as shown in Figs. 2 and 3, so as not to interfere with the motion of the dipper handle.

When composite wood and steel booms were first applied to heavy shovels, they were made with a maximum section near the mid-length, tapering away toward the ends, following the shape of the steel booms which they displaced. This shape, it is claimed, was found unsuitable for wooden booms due to the effect of the grain of the wood, and it will be noted in Fig. 2 that the boom of the present shovel is of uniform width, or depth, from end to end except for a short taper at the base where it is attached to the swing circle.

The thrusting or crowding engine has two 9x9-in. cylinders and is controlled by a piston reverse valve. The method of mounting it on the boom is worthy of some description. The twisting of the boom when the bucket is being swung around with a load, especially if the swinging motion is begun before the bucket is free from the cut, may cause considerable relative movement between the two main members of the boom. The problem is to mount the thrusting engine on the boom in some way that will allow this weaving or twisting motion to take place without danger of cracking the engine bed. This is done in the Bucyrus shovel by the system of three-point support shown in Fig. 3. At the higher end, next the shipper shaft, the engine bed is bolted to both members of the boom, but the bed is here in contact with the boom for a length of only 18 or 20 in. At the lower end, to the left in Fig. 3, the engine bed is supported only at the center-line, by a metal block a few inches wide, and is secured by a single bolt which is also on the center-line.

The front end of the car body, on the

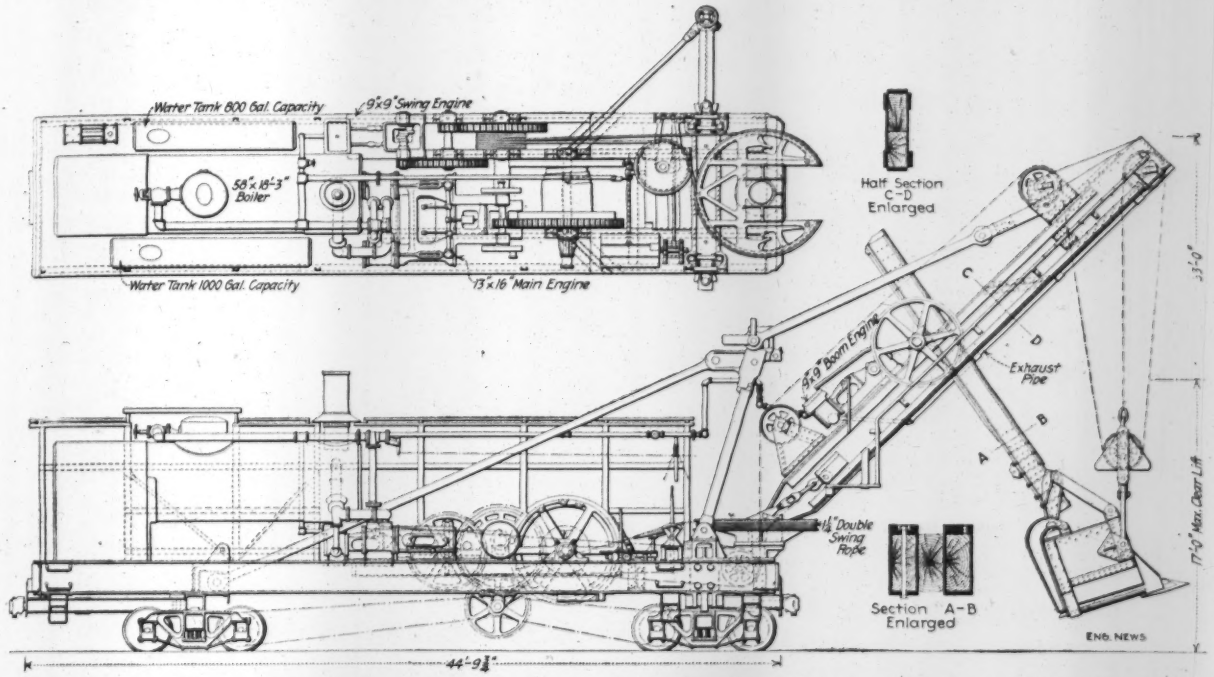



FIG. 2. SIDE ELEVATION AND PLAN OF THE BUCYRUS SHOVEL, WITH SECTIONAL VIEWS OF THE BOOM AND DIPPER HANDLE

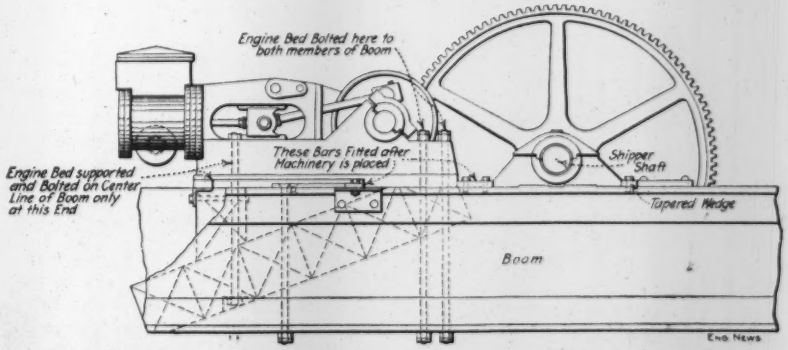

Engine Bed Bolted here to both members of Boom
These Bars Fitted after Machinery is placed
Shipper Shaft
Engine Bed supported and Bolted on Center Line of Boom only at this End
Tapered Wedge
Boom
ENG. NEWS

FIG. 3. DIAGRAM SHOWING THREE-POINT MOUNTING OF THRUSTING ENGINE

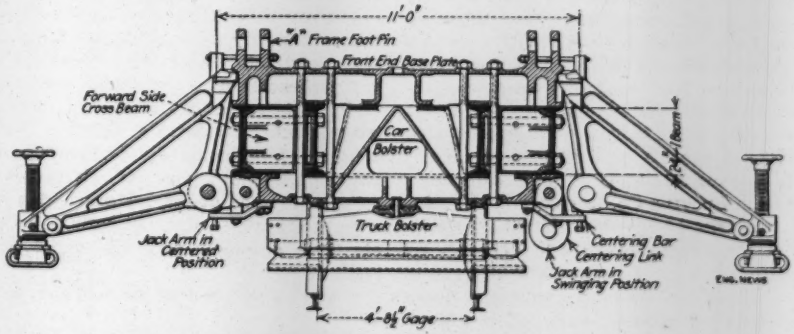



FIG. 4. FRONT ELEVATION OF FRONT END OF CAR BODY

earlier shovels built by the same company, was made up of a number of heavy castings and channels held together by finished bolts. The number of these castings was gradually cut down in later models to give a simpler and more rigid construction. In the case of the present shovel, the front end is practically one complete steel casting.

This front-end construction is shown in Fig. 4. On the four 24-in. I-beams that form the sills of the car body, rests a heavy steel casting known as the base-plate. This casting has integral with it the pintle on which the boom and swing circle revolve, the upper sockets for the jack arms and the supports for the legs of the A-frame which bears the weight of the boom and dipper handle. This casting is bolted to the car bolster, also of cast steel, which extends across the car body immediately below the sills. Under the middle of the car, a heavy lug, cast integraly with the car blister, projects upward to bear against the under side of the base-plate casting. In addition to the regular center and side bearings, the car-bolster casting includes the lugs for attaching the tension members of the jack arms. The truck bolster is likewise a single steel casting, as are the side frames and the forward journal boxes.

The swing circle on this shovel is also one complete steel casting, instead of being built up of structural steel. The outer rim is machined to receive the 1¼-in. swing ropes. It is claimed that this construction is desirable to withstand the frequent shocks and stresses to which the swing circle is subjected, not only in the course of ordinary digging and in the effort to stop swinging with a heavy load, but by the possible impact of the dipper against the swing-circle rim. These stresses have a tendency to loosen the rivets and bolts of a built-up circle.

Steam for the main engine and for the thrusting and the swinging engines is supplied by a horizontal boiler of the long-barrel locomotive type. It is 58 in. in diameter by 18 ft. 3 in. long and is designed for a working pressure of 140 lb. per sq.in. One of the many interesting points in the history of steam-shovel construction is the gradual development of an appreciation of the advantages of installing an efficient boiler. Shovels built 20 years ago were regularly equipped with vertical boilers, which were considered superior because they took less floor space. Present-day requirements, however, have resulted in the installation of boilers of the locomotive type on shovels over 50 tons in weight. In the summer of 1910, tests were made by the Bucyrus Co. to ascertain the relative merits of long and short-barrel boilers for steam-shovel work. These tests were made on Chicago & Northwestern Ry. work in Wisconsin, where a large number of shovels with both types of boilers were in operation under the same conditions. We are informed that a 15% to 20% greater efficiency was found for the long boilers as compared with the shorter ones.

In the summer of 1904, when the Isthmian Canal Commission placed some of its orders for steam shovels, the heaviest obtainable weighed in the neighborhood of 95 to 100 tons. These shovels, of several different makes, have been practically rebuilt in the repair shops on the isthmus to enable them to stand up to the work. Probably a much better showing in this respect would have been made if shovels of heavy construction, such as the one described, had been obtainable.

## Replacing Worn Bridge Pins in the Field

By H. C. Lothholz*

A somewhat novel method of replacing several chord pins by pins of larger diameter was recently used by C. F. Loweth, chief engineer of the Chicago, Milwaukee & St. Paul Ry., in repairing a pin-connected through-truss drawbridge of that company over the North Branch of the Chicago River. It is a single-track, counterbalanced, pin-connected, swing span. The long arm is 143 ft. and the short arm 87 ft. from end to center of drum, respectively, as shown in Fig. 1.

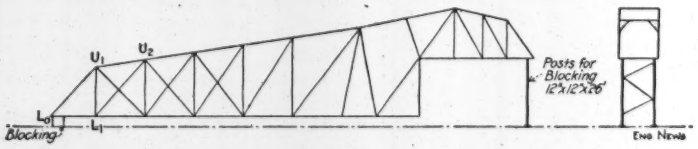



Fig. 1. Swing Bridge Whose End Pins Were Renewed: Chicago, Milwaukee & St. Paul Ry.

At the points *L*-0 and *U*-1 for both trusses it was found that the pins [the end pins of the lower and upper chords] showed a very noticeable movement during the passage of trains over the bridge. Some means of reaming out the old pin holes and replacing the pins with others of slightly larger diameter was desired. This work would have to be done during a single day, as the traffic conditions demanded that the bridge be kept out of service as short a time as possible.

The cause of the looseness of the pins was not clearly determined, as the figured stresses to which they are subjected are not excessive. The traffic over the bridge is heavy, being entirely of freight trains, with considerable stopping and starting of trains on the bridge due to switching, the lead track for a large yard being at the end of the bridge. There is a probability, also, that the boring of the pin holes originally was not very accurately done.

It was evident that as the boring of the pin holes had to be done in the field, the members forming the joints *L*-0 and *U*-1 would have to be held perfectly rigid, as any displacement of these members during the boring would seriously affect the distribution of the stresses in these members after the bridge was put into service again. This was kept in mind in designing the temporary brackets which hold these members in place while the repairs were being made.

The work was done by the railway company's forces on Nov. 6, 1911, the bridge being out of service between 6 a.m. and 9 p.m. As much as possible of the preliminary work was done on the day before. The details of the work at the top chord are shown in Fig. 2. The rivets in the end portal were removed and replaced by bolts. At *U*-1 the reinforcing gusset plates were put in and bolted loosely. These gusset plates were connected to the top chord and batter post by the holes for the batten plates, which had been temporarily removed, and by holes in the webs of both members, from which the rivets had been removed. The hanger *U*-1 *L*-1 was connected to these gusset plates by means of holes drilled through the webs of the channels of which the hanger was made. The eye bars *U*-1 *L*-2 were connected to the gusset plates by clamping them with long bolts, using wood fillers between. The arrangement at the end of the bottom chord is shown in Fig. 3. At *L*-0 the bracket was put in place to hold the batter post and bottom chord. This bracket consists of a heavy bent plate and two diaphragms. This was connected to the truss members through holes for batten plates, which had been temporarily removed.

On the day on which the pin holes were bored the span was first swung open and blocked up at the extreme ends. The jacks under these points raised them enough to practically relieve the members at the end of the bridge of all stress. The brackets at *L*-0 and *U*-1 were then bolted tightly, the portal bracing removed and both pins at *U*-1 were driven out. The pins were found very noticeably worn, as well as the pin holes.

The boring of the holes was done by machinists from the machine shops of the railway company. The tool used was a Ryerson portable boring bar which is ordinarily used for boring out locomotive cylinders. This boring bar was a long steel shaft about 3½ in. diameter, which was passed through the pin hole and supported by bearings which were clamped

*Office Engineer, Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.

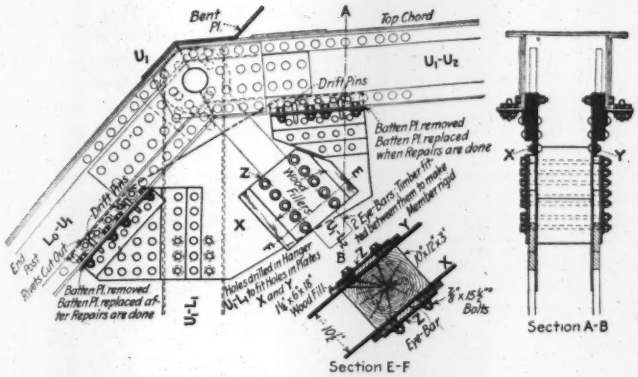



FIG. 2. ARRANGEMENT FOR HOLDING END POST AND TOP CHORD TOGETHER TO ALLOW OF REMOVING THE PIN

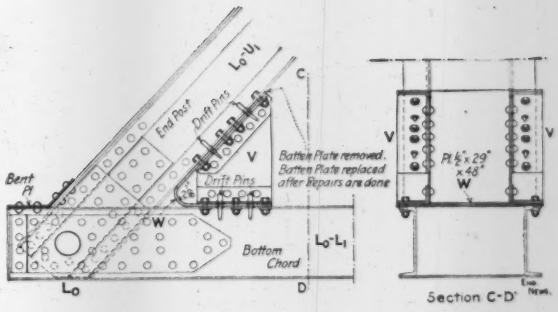



FIG. 3. ARRANGEMENT FOR HOLDING END POST AND BOTTOM CHORD TOGETHER TO ALLOW OF REMOVING THE END PIN

to the chord on each side. This boring bar was rotated on its own axis by a train of gears which forms a part of the tool. Power was transmitted to the gears by means of a small compressed-air motor driven by air from the compressor car of the bridge-erecting outfit. The cutting tool was fastened to a collar encircling the boring bar. This collar was fed along the axis of the boring bar, and thus both webs of the chord could be bored with a single setting of the cutting tool.

A machine lathe, set up in a box car and driven by a gasoline motor, had been brought from the shops to facilitate the fitting of the new pins. This expedient, which was due to the foresight of the foreman in charge of the boring, saved several hours of time, which was a vital factor. The new pin had been left $5\frac{7}{16}$ in. diameter, and as the hole in the chord (originally 5 in. diameter) approached $5\frac{1}{4}$ in. diameter due to the boring, the machinist in the box car turned down the pin to suit. By the time the boring bar finished its last cut the pin had been turned to a corresponding diameter and was ready to drive. Both the new pins were driven at *U*-1. Then the old pins at *L*-0 were removed, the holes bored and the new pins substituted.

The result obtained was entirely satisfactory. This method appears to be the only one which could have been used in this case. If the members affected had been taken down and bored in the shop, the bridge would have had to be taken out of service for several days, which would have been out of the question for this kind of a repair. In fixed truss bridges, chord pins could be replaced one at a time by this method by pins about ½ in. greater in diameter, where it is possible to suspend traffic for three-hour periods.

This method was devised by and the details were worked out under the direction of the writer.

[Fig. 4 shows the boring tool in position for reaming out one of the pin holes in the top chord, and is reproduced from a photograph furnished by Joseph T. Ryerson & Son, of Chicago, by whom the tool was supplied to the railway company's locomotive shops. Beneath the machine is the air motor (lying on the plank platform), with its pinion engaging the train of gears by which the boring bar is driven. As noted above, the tool was part of the equipment of the locomotive shops, and was adapted to this new type of work by the engineers. The Chicago, Milwaukee & St. Paul Ry. does practically all its bridge work by its own forces.—EDITOR.]

FIG. 4. BORING MACHINE IN POSITION FOR BORING OUT HOLES FOR PINS IN TOP CHORD

**Preliminary Plans for a Civic Center** for San Francisco are before the Board of Supervisors of that city. It is reported that in response to an invitation from the mayor, over 50 plans have been submitted. The motive of the plans seems to be the grouping of various public buildings around a monumental city hall. One of the conditions of the plans is said to be the possibility of their consummation before March 1, 1915. It is reported that after the plans have been gone over by the Supervisors (a body corresponding to the usual city council) they will be submitted to the Architectural Commission of the Panama Pacific Exposition before any definite action upon the plans submitted will be taken.

# An Electric Hoist Traveler for Placing the Concrete Floor of a Viaduct

By C. M. Kurtz*

The plans of the Mission Bay Viaduct, now under construction by the Southern Pacific Co., in San Francisco, along portions of Sixth, Sixteenth and Kentucky Sts., and over the tracks of the Mission Bay Yards, crossing Sixteenth and Kentucky Sts., call for 2215 lin.ft. of structural steel bridgework supporting roadways 36 ft. wide, consisting of basalt blocks laid in asphalt mastic upon a reinforced-concrete floor 6 in. thick, and sidewalks, 11 ft. 4 in. wide, of reënforced concrete 4 in. thick.

The grade of the roadways and sidewalks on the viaduct averages from 25 to 30 ft. above the street grades and ground beneath the structure. In order, therefore, to convey the concrete from the plants on the ground quickly, conveniently and economically into place on the floor forms, an electric hoist traveler that gave excellent service and satisfaction was constructed and used.

*Construction department, Southern Pacific Co., 234 Iowa St., San Francisco, Calif.

The traveler (Fig. 1) consists of a framework made up of two 8x17-in. beams spanning the viaduct roadway and overhanging the sidewalk. The beams are trussed beneath by 1¼-in. round iron rods provided witih turnbuckles. The overhanging portions supporting the hoist tower are given stability by 1¼-in. round iron rods passing over 8x8-in. posts on the upper sides. The beams are framed together by means of the two pairs of 8x12-in. sills over each girder, three 8x12-in. spreaders, three ¾-in. bolts and two sets of 3x6-in. X-braces; they are 7 ft. apart, face to face, and support an 18-in. gage service track for the concrete cars.

The hoistng machinery is supported on a triangular shaped platform made by extending the 3x12-in. decking of the main framework over two 8x17-in. stringers, which are bolted to the beam at one end and carried by the 8x12-in. sills near the other. This platform is located in a position to enable the operator to have an unobstructed view of his load while handling levers.

The traveler is supported by five 14-in. double-flange wheels running on 3[illegible]-lb. rails clamped to the top of the viaduct girders by means of two clamps to each rail. A detail sketch of one of these clamps is shown in Fig. 1.

When not being moved, and while the hoist is in operation, absolute safety against overturning from any cause, is obtained by means of a wrought-iron clamp consisting of two dogs connected to a 1-in. eyebolt by means of a 3-in. ring, operated by a cranknut, and located on the end of the traveler opposite the hoist. The dogs of this clamp, consisting of two pieces of ¾x2½-in. strap iron, engage themselves firmly to the underside of the upper flanges of the viaduct girders when the cranknut is tightened.

At the hoist end of the traveler is a landing table, a 4x6½-ft. car, running on a 6-ft. gage track spanning the hoist opening. When a loaded concrete car has been hoisted up into the tower, the landing table is pushed underneath it, the car lowered and placed on the track upon the table. The table is then pulled in over the platform marked *P*, in Fig. 1, and the car pushed off onto the traveler track to the hopper over the chute in use

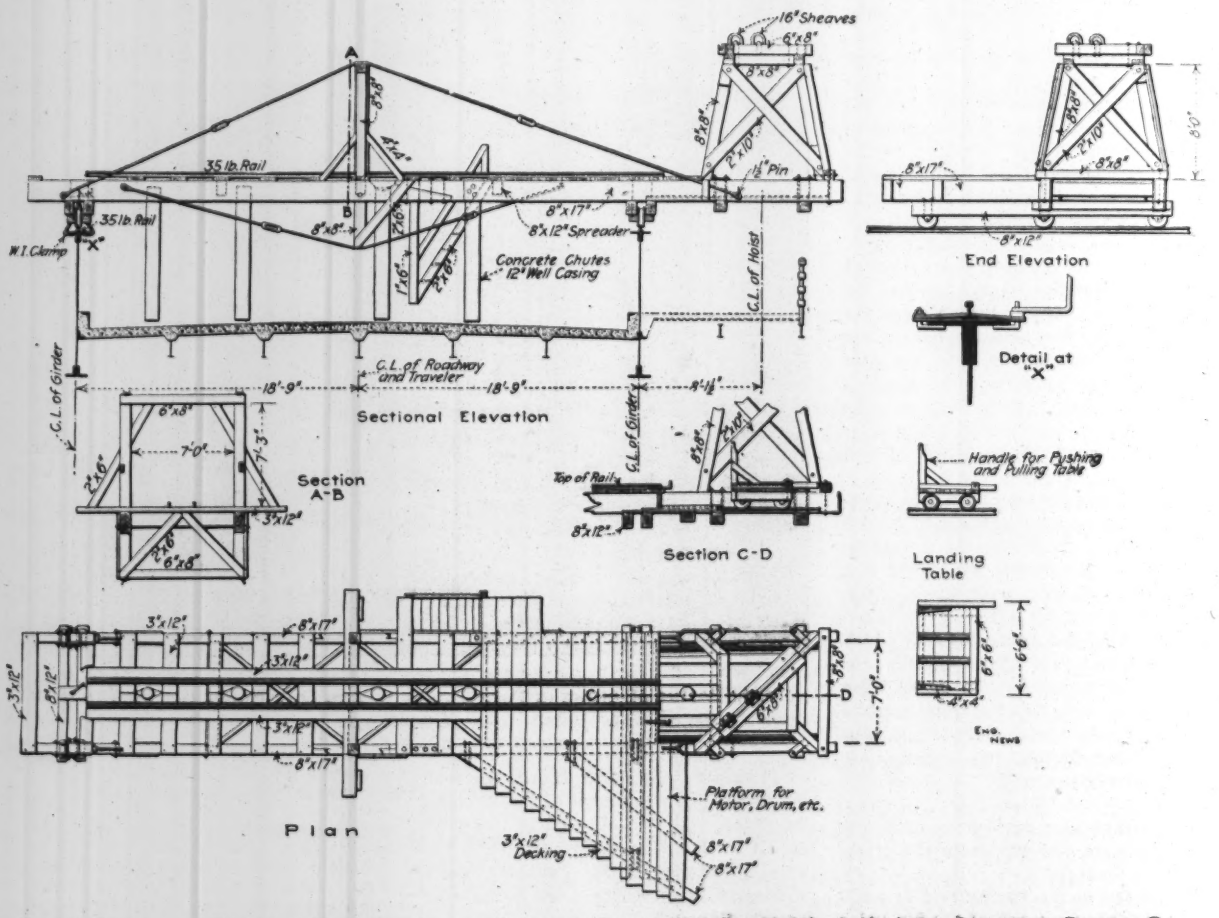



FIG. 1. DETAILS OF TRAVELER USED FOR LAYING CONCRETE FLOOR ON A PLATE-GIRDER VIADUCT, SOUTHERN PACIFIC CO.

at the time, and the contents dumped as shown in Fig. 2. This operation is reversed when the emptied car is returned to the mixer.

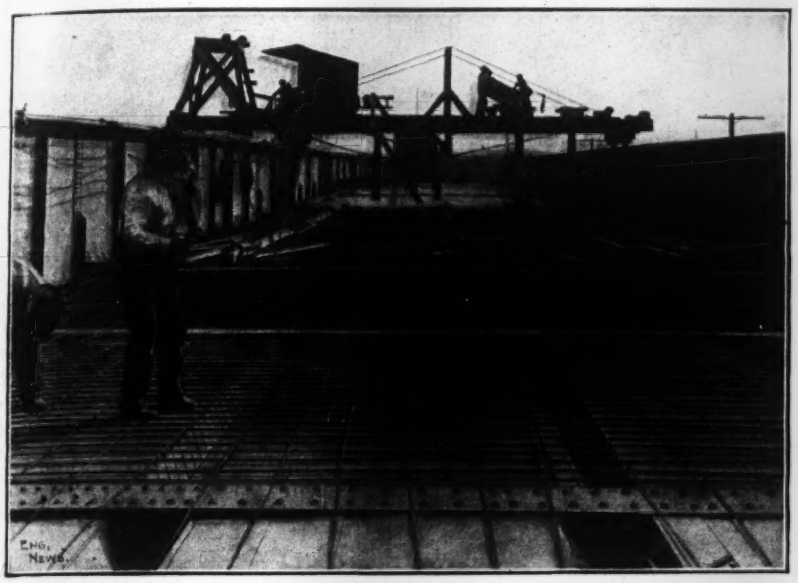


FIG. 2. VIEW OF TRAVELER IN ACTION
(Concrete hoisted from ground at left; rolled across traveler to chutes; being dumped through chute at right.)

By means of four chutes consisting of 12-in. well casing suspended from the traveler, the concrete is distributed in the roadway floor, from curb to curb.

The arrangement for moving the traveler ahead is shown in Fig. 2, being a pair of double blocks with one end attached to a rope bridle on the traveler, and the other end to an upper flange of a viaduct flooor beam, the lead line passing to the "gypsy" on the drum shaft of the electric hoist.

In placing the concrete in the sidewalk, the traveler is placed in a convenient position with respect to the concrete plant, and hand carts are employed in distributing the material. The concrete is dumped from the car while on the landing table, through the bottomless bucket *S* inserted in the platform *P*, as shown in Fig. 1. A chute (not shown in the figure) is suspended from the bucket, and conducts the concrete into the carts.

With the viaduct girder on one side, and sheer space on the other, the sidewalk becomes an extremely awkward structure to finish. It therefore became necessary to construct two carriages of special and novel design to travel above the sidewalk, for carrying the laborers while "floating" and marking the same. These are shown in Fig. 3, and it will be noted that the wheels of the carriages run on the tops of the girder and fence, and that the working platforms, consisting of 3x12-in. planks suspended on the light framework of wrought-iron rods, X-braced, clear the surface of the sidewalk by a few inches.

The equipment in use on the electric hoist traveler consists of the following:

One 20-hp. induction motor, 2-phase, 60-cycle;

One 20 to 30-hp. Westinghouse Electric Co. autostarter;

One double-throw switch, slate base, 150 amperes, 250 volts;

Two main-line 75-ampere cutouts, and 3 knifeblade contact fuses;

FIG. 3. CARRIAGES USED ON VIADUCT IN FLOATING AND MARKING SIDEWALKS

One drum and gypsy;

One ⅞-in. wire cable with hook;

One set of slings and stretcher bar (for handling cars in hoist).

The motor and drum are direct-connected. All of the above equipment, as well as all of the material used in the construction of the traveler, is second-hand, having been used by the company on other construction work in San Francisco.

The power for operating the hoist is furnished by the S. F. Gas & Electric Co., the wires being suspended from the viaduct girder, as shown in Fig. 2.

The plans for the traveler were drawn by the writer in the office of J. W. O'Brien, assistant engineer, who has direct charge of the construction of the Mission Bay Viaduct.

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**Reinforced-Concrete Pavements** have been laid in Plymouth, Wis., and Fond du Lac, Wis., in the past two or three years, according to a recent issue of the "Municipal Journal." These pavements are reinforced by a woven wire mesh placed directly on the base concrete so as to lie between the surface coat and the base. In most respects they are similar to the ordinary concrete pavement, the base consisting of a 5-in. thickness of large aggregate concrete, and the surface coat a 1½-in. layer of concrete made up of small material of a size to pass through rings ranging from ¼ to ¾ in. in diameter. In the Plymouth pavement the surface was roughened by throwing on it, while still soft and wet, small granite chips ranging from ¼ to ⅜ in. These formed a roughened surface, which makes the roadway much easier for the horses to travel. The Fond du Lac pavement surface is roughened by brushing while still damp with a stiff broom. At Plymouth a novelty was introduced in the way of cypress strips for expansion joints. By the use of these strips, which were laid vertically flat alongside the curb, and the car tracks where there were car tracks, the roadway was divided up into 40-ft. square areas, strips being placed between the curbs to form the expansion joints. In addition to forming expansion joints, these wooden strips also served the purpose of templates.

# FIELD AND OFFICE

## An Automobile Reconnaissance of a Trunk Highway

By Samuel H. Lea*
M. Am. Soc. C. E.

The writer recently completed an automobile reconnaissance over country roads across the State of South Dakota for a proposed highway known as the Meridian Road. It is thought that an account of the engineering work involved in this trip would be of interest.

FIG. 1. ROUTE OF THE MERIDIAN ROAD FROM GALVESTON TO WINNIPEG

The proposed trunk highway across the state is a part of the project to build a continuous road from Winnipeg, Canada, southward across the United States to Galveston, Tex. Up to the present time, no general organization has been effected; each state is looking after that portion of the road comprised within its boundaries. The intention is to follow a meridian as closely as practicable, hence the name Meridian Road. Existing roads are to be utilized as far as possible; these are to be improved and made to conform to certain standards. In locating the road it was considered necessary to take into consideration all factors essential to an international and interstate highway, with due attention, however, to local conditions affecting construction, maintenance and expected traffic. The plan is to construct a good earth road with reasonable grades, properly formed roadway, and suitable provision for drainage. The road is to be surveyed and built under competent engineering supervision, and maintained in a first-class condition after completion. The general route across the United States is shown in Fig. 1. The road will enter South Dakota at Yankton, where the Missouri River will be crossed on a pontoon bridge. From Yankton the route is due north to the county line, a distance of 24 miles. In other counties the line has a northerly direction offset to the west at first and to the east later.

In planning the reconnaissance, first the general route was determined with important towns considered as objective points. The decision of the most feasible route between successive towns was to be based on the reconnaissance.

Advance notices were sent to the various communities along the route and mayors and officers of commercial associations and automobile clubs were corresponded with. In this way arrangements were made in advance for transportation for the party from place to place, as well as for subsistence along the route. Both of these features were satisfactorily carried out and there was no delay or misunderstanding on the entire trip.

The party comprised four members who made the trip across the state; each individual performed some duty. The writer was assisted in the field work by Prof. A. B. McDaniel, of the State University; the other members of the party were Thomas Edwards, a Yankton County Commissioner, and W. H. Burden, a newspaper correspondent. At places where stops were made, the writer explained the proposition to the assembled audiences, displaying a large map prepared to show the entire route from Galveston to Winnipeg. Mr. Edwards addressed the various audiences, stating the action taken by the Yankton County Board of Commissioners in appropriating money for construction, and telling of steps taken toward forming a permanent local organization. Mr. Burden gave information concerning the trip to local newspaper men along the route and furnished news of the trip to a number of newspapers about the state. He telephoned ahead from place to place, notifying towns along the route of the progress of the party, time of expected arrival, etc.

In making the trip, one automobile was reserved for the two engineers, who occupied the back seat; the writer acted as observer and Prof. McDaniel recorded the notes. In the front seat would be a resident of the county through which we were then passing; from him we obtained information concerning local deposits of gravel and other road-building materials, nature of soil, etc. As we changed machines from time to time (each town along the route furnished transportation and escort through its adjacent territory) we were assured of competent local guides along the entire route.

The itinerary was prepared with the expectation of covering from 75 to 100 miles a day on the trip; it was found impracticable, however, to carry out this program. Along some portions of the route bad roads necessitated slow traveling and this, of course, caused delays. Other delays were caused by making longer stops than originally intended at small towns where people had assembled to hear the proposition explained. Each day, before starting out, members of local automobile clubs and others familiar with the country ahead were consulted. A route would then be selected; this was next marked in red ink on a county map showing township and section lines. In some instances it was considered necessary to examine more than one route,

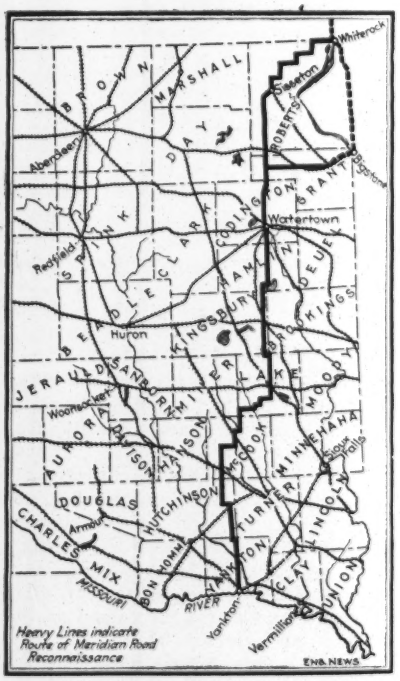



FIG. 2. THE MERIDIAN ROAD IN SOUTH DAKOTA

*State engineer of South Dakota, Pierre, S. D.

and in such cases each route would be shown on the map.

While traveling, the observer, seated in the car beside the recorder, held the county map open before him and kept track of the section and township numbers as the car moved along. This it was possible to do along the greater portion of the way, for the boundary of each section or square mile of land was designated by a roadway, 66 ft. wide, between adjacent sections. The observer also noted the condition of the country roads traversed, with a view to possible improvement later on. At places where the section boundaries were not well defined, distances were determined by noting the registrations of the speedometer or autometer attached to the car.

The recorder was provided with a pad of writing paper and a soft pencil, to insure ease and rapidity in writing down the notes. These were made as full and complete as possible, the intention being to transcribe them later on in a more permanent form. The equipment included a hand level for use in estimating grades at hills and stream crossings.

As the car traveled along the engineers made careful observations of the different physical and topographic features along the way and at the end of each mile a stop was made to record the notes of the mile that had just been traversed. At first, in order to save time, the recorder attempted to write down the notes while traveling, without stopping the machine, but this was abandoned after trial. It was found that writing could not be done satisfactorily while the car was going even at moderate speed. These stops made the journey much slower, but the time required for them, from two to three minutes for each mile, was considered well spent. The impressions were recorded while they were fresh in mind. Recommendations for road improvement were made a part of the notes.

A total distance of 275 miles is covered by the most direct and feasible route across the state. In making the reconnaissance it was found necessary, where rival routes existed, to make examination of more than one route in order to determine their relative merits. This raised the total length of roads examined in the state to 394 miles, an excess of 119 miles over the actual length of the Meridian Road in the state.

The trip from Yankton to White Rock, including examination of alternative routes, was made in five days, inslusive, or from Oct. 23 to Oct, 27, 1911. On Oct. 28, the party, now reduced to the two engineer members, accompanied a delegation from North Dakota to the city of Fargo, where a stop was made over Sunday. From Fargo we returned by train to White Rock, where we began on Monday morning (Oct. 30) a trip southward through Minnesota and South Dakota. No detail notes were taken until we reëntered South Dakota at Big Stone City. From that point we examined 38 miles of line until we reached the roads north of Watertown, already covered. We arrived at Watertown on Oct. 30, at 7 p.m., having covered a distance of 123 miles by automobile during the day.

With the exception of some steep grades crossing the James River valley in Yankton County, the roads were fairly good. Like most country roads, however, local drainage had been neglected and the surface needed dragging. The same general conditions were found all along the route. In the adjacent counties to the north, some of the worst roads on the entire trip were encountered. Several places were found where recent rains had formed ponds or sloughs, for which no drainage had been provided. At some of these places, where attempts to cross by our party were made at high speed, the machines were stuck in the mud and much effort was required to pull them out. Better conditions were found as we continued northward; the improvement was due mainly to the drying out of the roads rather than to better construction or maintenance. At some of the places we passed through, recent attempts had been made to put the roads in better condition by dragging them; all such efforts had resulted in decided improvement to the road surfaces.

## Engineering Organization and Methods of the Coleman Du Pont Road*

The Coleman Du Pont Road, Incorporated, came into being in accordance with an act by the Delaware Legislature, passed to facilitate General Coleman duPont's gift, which act authorized any boulevard company to construct a free highway from some point on the southern boundary of Delaware to a point in the vicinity of Wilmington in the northern part of the State.

The engineering organization of the Road now consists of the Chief Engineer, an assistant chief engineer, one division engineer for each of the three counties of New Castle, Kent and Sussex, a chief draftsman in charge of the department of plans and estimates, and a testing engineer in charge of the testing laboratory. There are fourteen assistant engineers with a full complement of instrument men, rodmen, chainmen and axmen, besides a corps of draftsmen. A large field force was made necessary by General duPont's purpose to place the road where most desired by the greatest number of residents, in keeping with the general scheme of as direct a location as possible. This purpose made it necessary to run numerous preliminary lines.

*Abstract of a paper prepared by F. M. Williams, Chief Engineer, for the American Association for the Advancement of Science.

Inasmuch as it is the purpose of the company to build a considerable portion of the road with its own forces, there is in addition to the above a construction department under the engineering department. This part of the organization will be much amplified in the spring, when construction work will be pushed as rapidly as possible.

In perfecting the engineering organization it has been the purpose to place responsibility for preliminary and final survey work and for construction work upon the division engineers, and for that reason each division engineer has full authority to discharge any employee working under him, and in most cases has authority to hire his own assistants.

PRELIMINARY LOCATION—When it is decided by the chief engineer to run a certain line, notification is sent to the division engineer in whose division the line is located; it is his duty to put a party in the field at the earliest possible moment to make a survey of the line in question, locating as much topography as may be necessary to permit of paper location being made from the field notes. Particular attention must be paid to locating property lines between various owners and obtaining the correct names of owners, inasmuch as 95% of the road will be on entirely new location; and since property lines are not well defined by fences in country where cattle raising is rare, this requires considerable care. The division engineer then sends in, drawn to a 500-ft.-to-an-inch scale, a plot of the line as run. This plot is then adjusted, paper location made, traced, blueprinted, and one copy turned over to the right-of-way department and one each to the chief and division engineers. Preliminary survey parties consist of an assistant engineer in charge, transitmen, two chainmen, two rodmen, and axmen.

As there are no adequate maps of southern Delaware, and as the country is exceedingly level, it was necessary in that portion of the State to evolve some scheme for connecting desirable points without the necessity of running numerous random lines. This was accomplished by sending up rockets at night and obtaining a line of sight on them. In one case a rocket was plainly visible at a distance of fourteen miles, and the line which was run from the sight thus taken struck the desired point within a very few feet. These rockets, made especially for this work, are of 2, 4 and 8 lb. weight. Each is equipped with a parachute, carrying a light of changing color and capable of sustaining itself in the air for nearly a minute. The utility of such a plan must be apparent to anyone familiar with the topography of southern Delaware, where the general surface of the ground varies in elevation from 30 to 50 ft. above sea-level and, being heavily wooded at frequent inter-

vals, furnishes slight opportunity for usual methods of location.

Very often it is necessary to supplement the original preliminary surveys with a number of cut-off lines or side locations to avoid impracticable crossings of rivers or swamps or to avoid right-of-way difficulties which the long tangents of the first line very often involve. Preliminary surveys also include the running of such random lines off the original line as prove necessary to develop the general area of watersheds and the location of mill ponds and dams, of which the southern part of Delaware has a great number. Up to the present time it has been necessary to run about 470 miles of preliminary location besides the incidental work mentioned above. This preliminary work has now been finished in the county of Sussex, but there are four preliminary parties working in each of the other two counties.

After the right-of-way department has favorably reported on the line as run and the location has received the approval of General duPont, it is referred to the State Commission, composed of the Governor, Lieutenant-Governor and Secretary of State. Maps are furnished to this commission showing the proposed location, and a personal inspection of the route is made by them. If they approve such proposed location it is signified by their signing the plans, and then the engineering organization takes up the matter of final location surveys and preparations of plans and estimates.

FINAL LOCATION—Final-location survey parties have in general the same organization as the preliminary parties, except that they require one less axman and the addition of a stakeman and a property-line man. It is the duty of the latter to interview property owners and have them on the ground when the survey party crosses to point out and agree on the division lines between their respective properties.

It has been decided to run all final surveys by the azimuth method, locating a primary base from polar observations and referring the bearings of all lines to the true north. Night observations are taken every five or six miles of line run, as a check upon the original work. It is designed when this work is completed to leave behind a base line extending from one end of the state to the other, which may serve ultimately for referencing adjacent property surveys.

The right-of-way taken is uniformly 200 ft. in width, with the exception of its location through three or four of the larger towns and cities, where it will be reduced to 120 ft. It is the duty of the final-location party to locate all topography within the right-of-way lines and for 100 ft. on either side, also to locate with a fair degree of accuracy the highways leading from the right-of-way to the nearest railroad or dock, giving directions and distances. The center line is marked by tack-centered stakes, set 300 ft. apart except at transit points and on curves. All curves have stakes set at each 100-ft. station. Tack-centered stakes are set at the intersection of the right-of-way lines with every property line crossed and also uniformly at each 1000-ft. station.

Two general limits have been established for final location. One is that the limiting degree of curvature for the entire line shall be 5°, and the other that the limiting rate of grade for Sussex County shall be 2%. The limiting rate of grade in Kent County and in New Castle County has not as yet been established, but it seems probable that it will be 3% in the former and 5% in the latter.

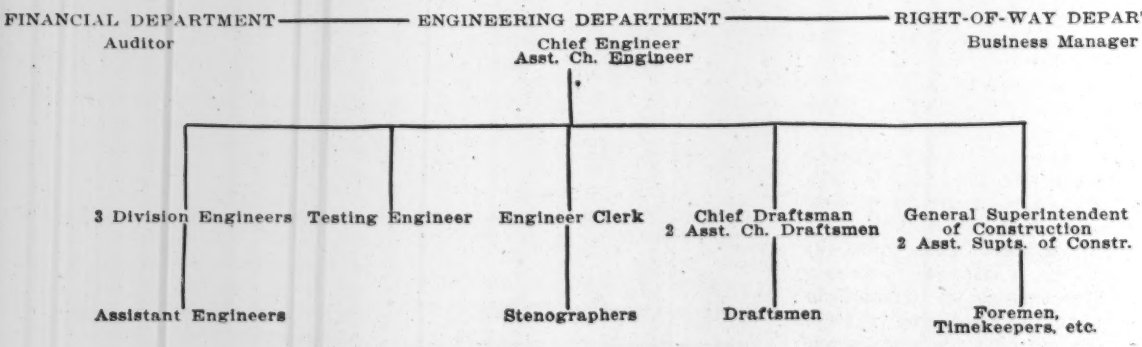
Granite or concrete monuments will be set on both right-of-way lines 1000 ft. apart, and these monuments will be carefully centered and every location checked and rechecked so that the lines which they mark may have an accurate azimuth determination. There will also be placed along the line of the road permanent monuments marked with the accurate distances between the southern boundary of Delaware and the principal points in the state north of it.

A cross-section party closely follows the final-location party, taking sections in the usual manner. It is the duty of this party also to develop existing and possible drainage courses and determine the avaliable fall. This is highly important in a country as flat as that of Sussex County and the southern part of Kent County. The cross-section party establishes benchmarks at intervals not greater than 1000 ft. for use in construction, the datum assumed being that of the United States Geological Survey. The organization of the cross-section party consists of an assistant engineer in charge, instrument man and two rodmen. Up to the present time about 70 mi. of cross-sections have been taken.

As fast as the fieldwork for the final surveys and cross-sections has been completed the notes are forwarded to the Wilmington office for platting. The location notes sent in are platted on two scales. One plat is made on the scale of 500 ft. to the inch, showing the adjacent railroad switches and barge docks with the highways leading from them to the proposed route, as well as the line of the proposed route itself and the various topography upon it. The construction plans are made in standard size of 24x36 in., giving the plan on a scale of 100 ft. to the inch and the profile and grade line on a scale of 10 ft. vertically and 100 ft. horizontally. The road sections are generally in the form of standards and are on a scale of 10 ft. to the inch.

REVISION AND PLAN MAKING—After the planning of the notes has been completed, an experienced road engineer is sent over the line with a blueprint showing the profile with a trial grade line, to make such changes as may be necessary to provide better for the distribution of materials and the perfection of the drainage system. This work is in the hands of the department of plans and estimates, but employs the division engineer of each division in a consulting capacity as to the work planned for his particular division.

The organization of the department of plans and estimates comprises the Chief Draftsman, two assistant chief draftsmen, and a requisite number of draftsmen, tracers, calculators, etc. Attached




ORGANIZATION DIAGRAM OF THE ENGINEERING DEPARTMENT, COLEMAN DUPONT ROAD, INC.

to this office is also a blueprinting department. After the determination of the grades, sections, and type of road to be constructed, the plans and estimates are completed. Wherever possible, standards are employed for small structures, but anything requiring special treatment is made the subject of a special plan. This department is under the direct supervision of the Assistant Chief Engineer.

TESTING AND ROAD STUDIES—The Testing Laboratory, directly under the supervision of the Chief Engineer, is in charge of a testing engineer and is thoroughly equipped for the testing of oils, asphalts, tars, cement and sand. The equipment of this laboratory is further supplemented by the testing laboratory of the E. I. du Pont de Nemours Powder Co.'s works.

Construction began late in the fall and has been carried on as vigorously as weather conditions would permit. Twelve miles of road have been graded and nearly all the culverts for this section have been built; about two miles of surfacing is nearing completion. The construction department, which has handled a considerable part of this work, is also engaged in the development of gravel pits and stone quarries. Early next spring it is planned to begin construction on the whole line.

As nearly as can now be determined the line will be about 106 miles in length.

## Steam Shovel Dipper Trips Used on the Panama Canal*

An investigation is under way to determine the relative efficiency of two steam-shovel trips, operated by steam, known as the Geddes and Wichman trips. These are the culmination of a development in the improvement of dipper-tripping devices that began soon after the first steam shovel was set to work in Culebra Cut.

When the dipper is loaded, the spoil within bears down upon the door and tends to hold it firmly in place, so that the force required to open the latch is often considerable. When the shovels arrived on the Isthmus, they were equipped with a single-lever latch operated by a 1¼-in. rope in the hand of the craneman, attached at its other end to the dipper trip. Several jerks were often necessary to open the latch, and almost invariably a great effort was required.

The first improvement was to compound the lever system of this original trip, as shown in Fig. 1. The original arrangement was the simple lever with the fulcrum at *a*, the weight at *b* and the power at *c*.

Among improvements upon the compound-lever device, one that was given a trial in 1909, was the spring trip shown in Fig. 2. It consisted of a lever and a bar passing through a slot *e* in the latch, with a spring attached at its outer end, the power for unlatching being supplied by the spring. The door was closed by its own weight when in the

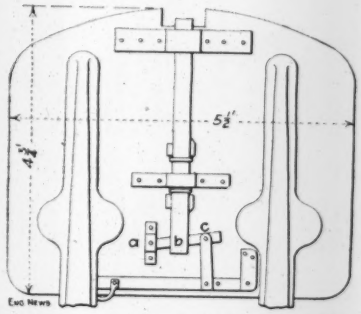



FIG. 1. COMPOUND-LEVER LATCH TRIP ON DIPPER DOOR OF A 95-TON STEAM SHOVEL

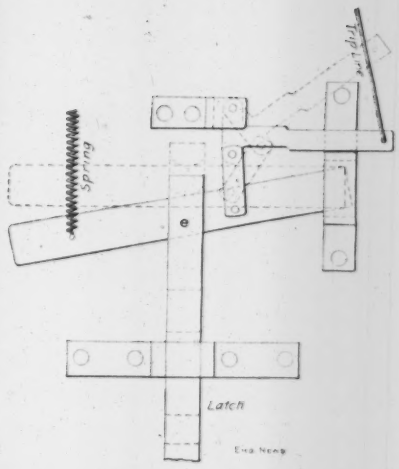



FIG. 2. SPRING LATCH TRIP ON STEAM-SHOVEL DIPPER DOOR

digging position, placing a tension of 1300 lb. upon the spring. This device worked satisfactorily, but the toggle joint required constant renewing and some difficulty was experienced in obtaining springs of suitable strength, so that the appliance was finally abandoned.

The first steam-power trip was a device placed upon his shovel by Thomas Custy, a steam-shovel engineer, in 1908, but after a few months' trial this was discarded. This device was improved upon by A. H. Geddes, also a steam-shovel engineer, until it became practicable, and a patent has been granted to him. The Geddes trip was described at length in the *Canal Record* of May 3, 1911. In this device a steam cylinder is located on the dipper trip near the dipper. The cylinder's piston is connected with the dipper latch through a chain and a series of levers, and when steam is admitted to the cylinder the rest of the system operates the levers and unlatches the door. After a thorough trial [see ENGINEERING NEWS, June 15, 1911, p. 727.—EDITOR] this device was adopted, upon the recommendation of a committee which reported that the capacity of a shovel could be increased 100 cu.yd. a day by its use.

The latest device, that shown in Fig. 3, was invented by F. S. Wichman, of the Mechanical Division. The latch is opened by a pull made upon a ½-in. wire rope by the outward thrust of the piston of an air-brake cylinder. The cylinder is mounted upon the boom of the shovel and a drum is mounted upon the face of the thrusting gear on the shipper shaft, which revolves with the shaft, thus winding or unwinding the trip rope

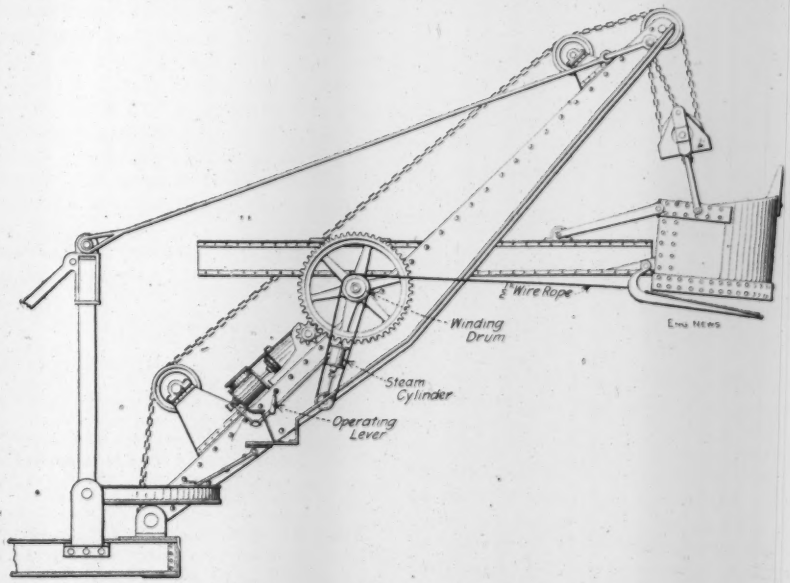



FIG. 3. SKETCH OF STEAM-SHOVEL BOOM SHOWING WICHMAN STEAM-OPERATED TRIPPING DEVICE

*Abstract of an article in the Canal Record of Nov. 8, 1911.

as the shipper shaft moves up or down. In this way the rope is kept taut at all times.

To give the lengthwise pull on the cable, a 6-in. diameter steam cylinder is mounted below the drum. The piston rod of this cylinder has a Y-yoke at its outer end to receive a sheave, over which the cable passes on its way to the drum. Steam admitted to the cylinder when it is desired to trip the dipper goes through a three-way cock operated by a lever at the craneman's seat. When the steam is not on, a spring in the cylinder moves the piston back into position and the tripping operation may be repeated. This device has undergone a successful test on two 95-ton steam shovels.

## The Vernier

By G. H. Bainbridge, Jr.*

Inasmuch as the vernier is an attachment common to so many of the instruments of engineering, and since the manufacturers of such instruments are now making the vernier in a variety of forms, it is hoped that the following discussion will be of use to those interested.

A vernier is a small, movable, auxiliary scale for obtaining fractional parts of the subdivisions of another scale called the main scale. The real object of the vernier is to afford a more convenient and practical method for measuring such fractional parts than would be possible if the main scale were directly graduated to such parts. The smallest fractional part of the smallest division on the main scale that a vernier will measure is its least count or smallest reading. The vernier is so named from Pierre Vernier, who invented the device in 1631.

There are in general two distinct and practical types of the vernier, the direct and the retrograde, each of which may be modified in a variety of ways without conflicting with the principle of the vernier.

The principle of the vernier is as follows:

An integral number of divisions on the vernier is made equal to an integral number, prime to the first, of divisions on the main scale.

The *direct* vernier is a vernier on which the numbering of the divisions increases in the same direction as the numbering of the divisions on the main scale.

The *retrograde* vernier is a vernier on which the numbering of the divisions increases in the opposite direction to the numbering of the divisions on the main scale.

From the principle of the vernier there results a lapping of vernier divisions by main-scale divisions, these laps or differences being equal to the least count of the vernier or some multiple of the least count.

*213 Hoosic St., Troy, N. Y.

The following symbols will be used in the mathematical discussion which follows:

$V_m$ = Value of smallest division on main scale;

$V_v$ = Value of smallest division on vernier, both to be expressed in terms of the same unit;

$N_m$ = Number of divisions of value $V_m$ which are exactly equal in total value;

$N_v$ = Number of divisions of value $V_v$;

$N_m$ and $N_v$ must be integers (considered positive) prime to each other, to comply with the principle of the vernier;

$K$ = A positive or negative integer;

$R_v$ = Least count or smallest reading of the vernier.

$$N_m V_m = N_v V_v \qquad (1)$$

$$\therefore N_m = \frac{N_v V_v}{V_m} \text{ and } N_v = \frac{N_m V_m}{V_v} \qquad (2)$$

$$N_v - N_m = K \qquad (3)$$

$$\therefore N_v - \frac{N_v V_v}{V_m} = K$$

$$\therefore \frac{N_v (V_m - V_v)}{V_m} = K$$

$$\therefore \frac{V_m - V_v}{K} = \frac{V_m}{N_v}$$

But

$$R_v = \frac{V_m - V_v}{K}$$

since the first lap counting from the zero of the vernier, is the $K$th multiple of $R_v$ (see Fig. 1);

$$\therefore R_v = \frac{V_m}{N_v} \qquad (4)$$

The direction in which the numbering of the divisions on the vernier increases with respect to that on the main scale shows whether the vernier is direct or retrograde. Eq. (4) gives the least count or smallest reading of the vernier, the quantities $V_m$ and $N_v$ being determined by inspection of the vernier in question.

The modifications of both types of the vernier arise from the different values of $K$ which the manufacturers adopt. Practice seems to favor $K$ equal to $\pm 1$, its minimum value numerically. In this case $N_v = N_m \pm 1$ from Eq. (3); the plus or minus sign is to be used according as the vernier is direct or retrograde. From this,

$$\frac{N_m V_m}{V_v} = N_m \pm 1$$

by Eq. (2), or

$$V_v = \frac{N_m}{N_m \pm 1} V_m$$

i.e., one division on the vernier is approximately equal to one division on the main scale.

Practical considerations as to space limitations, size of vernier, etc., tend to maintain $K = \pm 1$. But in some cases the divisions on the main scale have to be so fine that correspondingly fine divisions on the vernier ($K = \pm 1$) would defeat the very purpose of the vernier. There is a resulting and commendable tendency among manufacturers to adopt wherever feasible or necessary a value of $K$ equal to $\pm 1 - N_v$. With this value, Eq. (3) gives $2 N_v = N_m \pm 1$, and by use of Eq. (2),

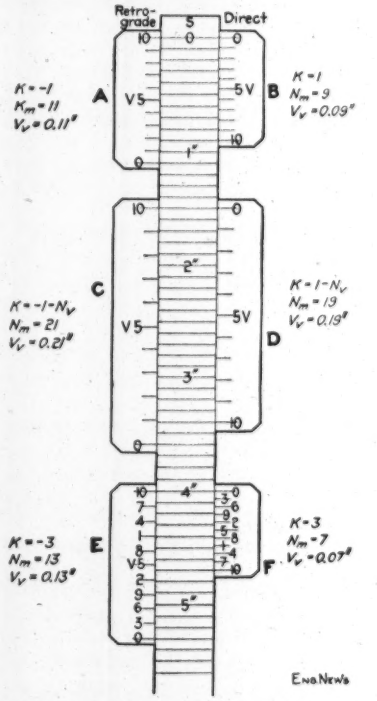
$$\frac{2 N_m V_m}{V_v} = N_m \pm 1$$

or

$$V_v = \frac{N_m}{N_m \pm 1} 2 V_m$$

i.e., one division on the vernier is approximately equal to two divisions on the main scale.

The value of $K = \pm 1 - N_v$ is probably the most satisfactory, particularly for circular verniers, for there is then greater contrast between the vernier and the main scale. There is, therefore, less chance of mistaking the vernier for the main scale, and *vice versa*, and the coincident mark is more readily obtained, all of which tends to accuracy and speed.




Examples of the Vernier: Six Different Verniers of Least Count 0.01 In. Applied to a One-tenth-in. Scale

The following is a list of instruments that have come to the writer's notice, having verniers with $K = \pm 1 - N_v$:

Draftsman's Protractor, and Improved Bevel Protractor, Brown & Sharpe Mfg. Co.; Improved Abney Level with rack movement, Eugene Dietzgen Co.; Sextant, Chas. P. Hutchinson, Boston, Mass.

The drawing herewith shows a main scale graduated to tenths of an inch and six different verniers, each having a least

count of 0.01 in. Therefore, from Eq. (4), since $Vm = 0.1$ in., $Nv$ equals 10. Verniers *B*, *D* and *F* are direct, and *A*, *C* and *E* are retrograde.

Verniers *E* and *F* are more or less freaks, but serve to show what effect the choice of $Nm$ and $Nv$ or $Vm$, for any least count $Rv$, has upon the problem. Vernier *F* in particular shows that by a careful selection of $Nm$ and $Nv$ or $Vm$, for any least count $Rv$, a vernier can be made quite small. This is a practical consideration where there is lack of room, in spite of the odd way the graduations may read.

Equations (1), (3) and (4) involve six quantities; therefore, if any three of the six are known, the remaining three can be found.

## Rapid Erection of Structural Steel Work

Rapid work in steel-building erection was done in Chicago recently and we have obtained some interesting particulars of this work. The building is for the printing establishment of Poole Brothers, and is near the corner of Harrison and Clark Sts. It is 50x100 ft., with three panels in the front and six at the side. There are corner columns at one side only, the beams of the end panel on the other side being connected to columns of an adjacent building. Seven floors were built, but the columns have connections for additional stories later. The columns are in two-story lengths and are built of Bethlehem H-beams and plates. All floor framing is of I-beams.

The weight of steel was about 400 tons and this was all placed and erected in 15 working days of 8 hours each, or 120 working hours. The erection was commenced on Nov. 29, and completed on Dec. 19; holidays, bad weather and Sundays account for the non-working time. The rapid progress of the work was due in large measure to the systematic delivery of the material from the yard so that no sorting had to be done at the site. The material was sorted and arranged at the yard, and sent out in regular order.

The erection was done with the aid of a 10-ton guyed derrick with 60-ft. boom. The heaviest pieces handled weighed 7 tons. The derrick could place material for two stories at one setting, so that it had to be raised four times during the work. The erecting gang was composed as follows: One foreman, 1 bell man (to give signals to engineman), 2 connectors, 2 hookers on, 1 pole man (to push the boom around), and a derrick engineman who acted also as fireman. The riveting was done by a following gang of four men with a pneumatic riveting hammer.

The architects were Holabird & Roche. The general contractors were J. P. & J. W. O'Connor, and the steelwork was manufactured by A. Bolter's Sons, all of Chicago. The contractor for the erection was C. M. Frain, 217 Chamber of Commerce, Chicago, and we are indebted to him for the information given above, as well as for a photograph of the work. The accompanying cut shows the steelwork completed, and the derrick still in place.

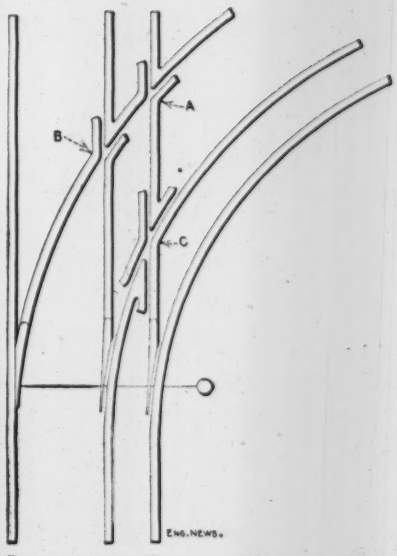
STRUCTURAL STEEL FRAME OF SEVEN-STORY BUILDING, CHICAGO

(400 tons erected in 120 working hours.)

Owing to changes being made in the plans but not correctly shown on the detail drawings, the lintel plate at the second-story level proved to be too wide, and after erection the excess width of this had to be sawed off along the entire street front of the building.

## Notes

**The Bending Moment of Lintel Beams** is usually determined on the assumption that the load on the beam consists of that part of the superincumbent wall bounded by a triangle whose base is the lintel and whose height is one-third the span of the lintel. To avoid the inconvenience of figuring the bending moment for such a triangular load, especially as tables for beams under uniform load are commonly available, it is advantageous to know the depth of uniform load giving the same maximum moment as the triangular load. C. W. Pinard, of Camden, N. J., points out that by writing the expressions for moment under triangular load and under uniform load it is found that the depth of uniform load, that is the height of rectangular section of wall, which will give the same moment as the triangular portion, is two-thirds the height of the triangle. In case the triangle is taken with a height one-third the span then the depth of uniform load should be two-ninths of the span. The equations by which this is demonstrated are simple and may be written down by anyone.




DOUBLE-GAGE TURNOUT USED ON MINE TRACKS

**Double-gage Turnouts**—Mr. Fred MacCoy, Chief Engineer of the Esperanza Mining Co., of El Oro, Mex., commenting upon the double-gage turnout at Porto Bello, Panama, illustrated in our issue of Nov. 23, 1911, p. 624, writes as follows:

I am unable to see the advantage of such an arrangement over the customary layout used around mines, where there are two gages in use, as, for instance, the mine gage and the surface gage.

I inclose a sketch of a turnout such as we use at this mine, which is also generally used all over Mexico where there are 36-in. and 4 ft. 8½-in. tracks used together. The frogs A and B are standard, and the frog C is a crossing frog (see Tratman's "Track and Track Work," p. 127, Fig. 63).

This turnout needs but one switch stand to throw both switches. A motor car may run on the wide gage and haul cars on the narrow gage.

**Weighing Scow Loads**—A simple method of determining weights of stone when loaded on scows preparatory for use in breakwater construction is given by Mr. Henry F. Alexander in a paper on "The Building of Breakwaters at Lake Erie Ports," published in the November Journal of the American Society of Engineering Contractors. This method is the ordinary one in use on the Great Lakes, but may be new to many readers. The scows are fitted with water tubes and gages, the number varying from two to six, according to the size of the scow. A hole is made in the bottom of the scow and in this is inserted an iron pipe that extends from the bottom of the scow to near the deck. To the outside of the pipe, near top and bottom, nipples are attached, and between them is a glass tube with a wooden gage graduated to feet and hundredths. The nipples are provided with cocks so that the water may be shut off from the tube when not in use. When only two gages are used one is located near the bow and the other near the stern, and equally distant from the side of the scow. The displacement of the scow for different loads is found by "weighing in." The gages are first read with the scow light and the average taken, which is called the "light reading." Then stone weigh-

## TABLE I. SECTION MODULI, AREAS AND WEIGHTS OF ANGLES FOR PLATE-GIRDERS

Column headings denote nominal girder depths in inches. Distance from back to back of angles was taken as ½-in. greater than nominal depth. Column A gives net area of two angles, one rivet hole per angle deducted. Column A′ gives net area of two angles, two rivet-holes per angle deducted. Column A″ gives gross area of four angles. Column W gives weight of four angles, pounds per lineal foot. Angles with unequal legs have the long leg outstanding. Rivet sizes assumed are ⅞-in. for angles over 4x3-in., and ¾-in. for 4x3 and 3x3 in.

### VALUES OF FOUR ANGLES WITHOUT COVER PLATES

**8x8**

| | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | A | W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | | 201 | 244 | 288 | 332 | 375 | 419 | 462 | 506 | 549 | 593 | 636 | 723 | 810 | 897 | 984 | 14.5 | 105.6 |
| ⅝ | | 224 | 273 | 322 | 371 | 420 | 469 | 517 | 566 | 615 | 664 | 712 | 810 | 908 | 1005 | 1103 | 16.23 | 118.4 |
| ¾ | | 248 | 302 | 356 | 409 | 463 | 517 | 571 | 625 | 679 | 733 | 787 | 895 | 1002 | 1110 | 1218 | 17.97 | 130.8 |
| ⅞ | | 271 | 330 | 389 | 448 | 507 | 566 | 625 | 684 | 743 | 802 | 861 | 979 | 1097 | 1215 | 1342 | 19.68 | 143.2 |
| 1 | | 293 | 357 | 421 | 485 | 549 | 613 | 678 | 742 | 806 | 870 | 934 | 1062 | 1191 | 1319 | 1447 | 21.38 | 155.6 |
| 1⅛ | | 315 | 384 | 453 | 522 | 591 | 661 | 727 | 796 | 865 | 934 | 1004 | 1142 | 1280 | 1408 | 1572 | 23.04 | 168.0 |
| 1¼ | | 337 | 411 | 485 | 559 | 633 | 708 | 782 | 856 | 930 | 1004 | 1078 | 1227 | 1375 | 1524 | 1672 | 24.70 | 180.0 |
| 1⅜ | | 358 | 437 | 516 | 596 | 675 | 754 | 833 | 912 | 991 | 1070 | 1150 | 1308 | 1466 | 1625 | 1783 | 26.36 | 192.4 |
| 1 | | 378 | 462 | 546 | 630 | 714 | 798 | 882 | 966 | 1050 | 1134 | 1218 | 1386 | 1544 | 1722 | 1890 | 28.0 | 204.0 |
| 1⅛ | | 399 | 488 | 577 | 666 | 755 | 844 | 933 | 1021 | 1110 | 1199 | 1288 | 1466 | 1641 | 1822 | 1999 | 29.6 | 216.0 |
| 1½ | | 420 | 513 | 607 | 700 | 794 | 888 | 982 | 1075 | 1169 | 1263 | 1356 | 1544 | 1731 | 1919 | 2106 | 31.23 | 227.6 |

**6x6**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 95 | 119 | 143 | 167 | 191 | 215 | 239 | 262 | 287 | 310 | 334 | 358 | 406 | 453 | 501 | 549 | 7.96 | 59.2 |
| ⅝ | 111 | 138 | 165 | 193 | 221 | 248 | 276 | 304 | 331 | 359 | 387 | 415 | 470 | 526 | 581 | 637 | 9.24 | 68.8 |
| ¾ | 125 | 156 | 187 | 219 | 250 | 282 | 313 | 345 | 376 | 408 | 439 | 471 | 534 | 597 | 660 | 723 | 10.5 | 78.4 |
| ⅞ | 140 | 175 | 210 | 245 | 280 | 315 | 351 | 386 | 421 | 456 | 491 | 526 | 597 | 667 | 738 | 808 | 11.74 | 87.6 |
| 1 | 152 | 191 | 230 | 269 | 308 | 347 | 386 | 422 | 463 | 502 | 541 | 580 | 658 | 736 | 814 | 892 | 12.96 | 96.8 |
| 1⅛ | 168 | 210 | 252 | 295 | 337 | 380 | 422 | 465 | 507 | 550 | 592 | 635 | 721 | 806 | 891 | 976 | 14.18 | 106.0 |
| 1¼ | 180 | 226 | 272 | 318 | 364 | 410 | 456 | 502 | 548 | 595 | 641 | 687 | 779 | 871 | 964 | 1056 | 15.38 | 114.8 |
| 1⅜ | 194 | 243 | 292 | 342 | 392 | 441 | 491 | 541 | 590 | 640 | 690 | 740 | 839 | 938 | 1038 | 1137 | 16.56 | 123.6 |
| 1½ | 206 | 259 | 312 | 365 | 418 | 471 | 525 | 578 | 631 | 684 | 737 | 791 | 898 | 1005 | 1112 | 1218 | 17.72 | 132.4 |
| 1⅝ | | 275 | 331 | 388 | 445 | 501 | 558 | 614 | 671 | 728 | 784 | 841 | 954 | 1067 | 1180 | 1293 | 18.86 | 141.2 |
| 1 | | 290 | 350 | 410 | 470 | 530 | 590 | 650 | 710 | 770 | 830 | 890 | 1010 | 1130 | 1250 | 1370 | 20.00 | 149.6 |

**6x4**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 86 | 106 | 126 | 145 | 164 | 184 | 203 | 222 | 242 | 261 | 280 | 300 | 339 | 378 | 416 | 455 | 6.46 | 49.2 |
| ⅝ | 100 | 122 | 144 | 167 | 189 | 212 | 235 | 257 | 279 | 302 | 325 | 347 | 392 | 437 | 481 | 525 | 7.48 | 57.2 |
| ¾ | 113 | 138 | 163 | 189 | 215 | 240 | 266 | 291 | 317 | 342 | 368 | 393 | 444 | 495 | 546 | 597 | 8.5 | 64.8 |
| ⅞ | 126 | 154 | 182 | 211 | 240 | 268 | 297 | 325 | 353 | 382 | 410 | 439 | 496 | 553 | 610 | 667 | 9.5 | 72.4 |
| 1 | 137 | 169 | 201 | 232 | 264 | 295 | 327 | 358 | 389 | 421 | 452 | 484 | 546 | 609 | 672 | 735 | 10.46 | 80.0 |
| 1⅛ | 149 | 184 | 219 | 255 | 288 | 322 | 356 | 391 | 425 | 459 | 494 | 528 | 597 | 665 | 734 | 803 | 11.44 | 87.2 |
| 1¼ | 162 | 199 | 236 | 273 | 311 | 348 | 385 | 422 | 459 | 496 | 533 | 571 | 645 | 719 | 793 | 868 | 12.38 | 94.4 |
| 1⅜ | 174 | 214 | 254 | 294 | 334 | 374 | 413 | 453 | 493 | 533 | 573 | 613 | 693 | 772 | 853 | 933 | 133.2 | 101.6 |
| 1½ | 186 | 228 | 270 | 313 | 356 | 399 | 441 | 484 | 527 | 569 | 612 | 655 | 740 | 825 | 911 | 996 | 14.22 | 108.8 |
| 1⅝ | | 241 | 287 | 332 | 378 | 423 | 468 | 514 | 559 | 605 | 650 | 695 | 786 | 877 | 968 | 1058 | 15.12 | 115.6 |
| 1 | | 255 | 303 | 351 | 399 | 447 | 495 | 543 | 591 | 639 | 687 | 735 | 831 | 927 | 1023 | 1119 | 16.0 | 122.4 |

**5x3½**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 73 | 89 | 105 | 121 | 137 | 153 | 169 | 185 | 201 | 217 | 233 | 249 | 281 | 313 | 345 | 377 | 5.34 | 41.6 |
| ⅝ | 84 | 102 | 120 | 139 | 158 | 176 | 195 | 213 | 232 | 250 | 269 | 288 | 325 | 362 | 399 | 436 | 6.18 | 48.0 |
| ¾ | 94 | 115 | 136 | 157 | 178 | 199 | 220 | 241 | 262 | 283 | 304 | 325 | 367 | 409 | 451 | 493 | 7.0 | 54.4 |
| ⅞ | 105 | 128 | 151 | 175 | 198 | 222 | 245 | 269 | 292 | 316 | 339 | 363 | 410 | 457 | 504 | 551 | 7.82 | 60.8 |
| 1 | 114 | 140 | 166 | 192 | 218 | 244 | 269 | 295 | 321 | 347 | 373 | 398 | 450 | 502 | 553 | 604 | 8.53 | 67.2 |
| 1⅛ | 124 | 153 | 181 | 209 | 237 | 265 | 293 | 321 | 349 | 377 | 406 | 434 | 490 | 546 | 602 | 638 | 9.36 | 73.2 |
| 1¼ | 133 | 16½ | 195 | 225 | 256 | 286 | 316 | 347 | 377 | 407 | 438 | 468 | 529 | 589 | 650 | 711 | 10.12 | 79.2 |
| 1⅜ | 144 | 177 | 209 | 242 | 274 | 307 | 339 | 372 | 405 | 437 | 470 | 503 | 568 | 633 | [illegible] | 764 | 10.88 | 85.2 |
| 1½ | 152 | 187 | 222 | 257 | 292 | 326 | 361 | 396 | 431 | 466 | 500 | 535 | 605 | 674 | 744 | 813 | 11.94 | 90.8 |

**4x4**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 64 | 79 | 94 | 109 | 124 | 139 | 154 | 169 | 184 | 199 | 214 | 228 | 258 | 288 | 318 | 348 | 4.97 | 39.2 |
| ⅝ | 75 | 92 | 109 | 126 | 143 | 160 | 178 | 195 | 212 | 229 | 247 | 264 | 298 | 333 | 367 | 402 | 5.74 | 45.2 |
| ¾ | 84 | 103 | 122 | 142 | 162 | 181 | 201 | 220 | 240 | 259 | 279 | 298 | 337 | 376 | 415 | 454 | 6.5 | 51.2 |
| ⅞ | 94 | 115 | 136 | 158 | 180 | 201 | 223 | 245 | 266 | 288 | 310 | 332 | 375 | 418 | 462 | 505 | 7923 | 57.2 |
| 1 | 102 | 125 | 150 | 174 | 198 | 221 | 245 | 269 | 293 | 317 | 341 | 365 | 413 | 461 | 508 | 556 | 7.97 | 62.8 |
| 1⅛ | 111 | 137 | 163 | 189 | 215 | 241 | 267 | 293 | 319 | 345 | 371 | 397 | 449 | 502 | 554 | 606 | 8.68 | 68.4 |
| 1¼ | 120 | 148 | 176 | 204 | 232 | 260 | 288 | 316 | 344 | 372 | 401 | 429 | 485 | 541 | 598 | 654 | 9.38 | 74.0 |
| 1⅜ | 129 | 158 | 188 | 228 | 248 | 278 | 308 | 339 | 369 | 399 | 423 | 459 | 520 | 580 | 640 | 701 | 10.05 | 79.6 |
| 1½ | | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | A | W |

**4x3**

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | A | W |
|---|---|---|---|---|---|---|---|---|---|
| ½ | 72 | 85 | 98 | 110 | 123 | 136 | 149 | 4.3 | 34.0 |
| ⅝ | 83 | 98 | 113 | 128 | 143 | 158 | 173 | 4.98 | 39.2 |
| ¾ | 93 | 110 | 127 | 144 | 161 | 178 | 195 | 5.62 | 44.4 |
| ⅞ | 103 | 122 | 141 | 160 | 179 | 197 | 216 | 6.26 | 49.6 |
| 1 | 113 | 133 | 154 | 175 | 195 | 216 | 236 | 6.86 | 54.4 |
| 1⅛ | 123 | 146 | 168 | 190 | 213 | 235 | 258 | 7.48 | 59.2 |
| 1¼ | 133 | 157 | 181 | 205 | 229 | 254 | 278 | 8.06 | 64.0 |

**3x3**

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | A | W |
|---|---|---|---|---|---|---|---|---|---|
| ½ | 60 | 70 | 80 | 91 | 101 | 112 | 123 | 3.56 | 28.8 |
| ⅝ | 68 | 80 | 92 | 104 | 117 | 129 | 141 | 4.1 | 33.2 |
| ¾ | 75 | 89 | 103 | 117 | 131 | 145 | 159 | 4.62 | 37.6 |
| ⅞ | 85 | 100 | 115 | 130 | 146 | 161 | 176 | 5.14 | 41.6 |
| 1 | 95 | 108 | 125 | 142 | 159 | 176 | 193 | 5.62 | 46.0 |

### VALUES OF FOUR ANGLES WITH COVER PLATES

**8x8**

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | A′ | A″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 187 | 227 | 268 | 309 | 349 | 390 | 430 | 471 | 511 | 552 | 592 | 673 | 754 | 835 | 916 | 13.5 | 31.0 |
| ⅝ | 209 | 255 | 300 | 345 | 391 | 431 | 482 | 527 | 572 | 618 | 663 | 754 | 845 | 936 | 1026 | 15.11 | 34.6 |
| ¾ | 231 | 281 | 331 | 381 | 431 | 481 | 532 | 582 | 632 | 682 | 732 | 832 | 933 | 1033 | 1133 | 16.72 | 38.4 |
| ⅞ | 252 | 307 | 362 | 417 | 471 | 526 | 581 | 636 | 691 | 746 | 801 | 911 | 1021 | 1131 | 1240 | 18.31 | 42.1 |
| 1 | 272 | 331 | 391 | 451 | 511 | 570 | 630 | 690 | 749 | 809 | 869 | 988 | 1107 | 1226 | 1346 | 19.88 | 45.7 |
| 1⅛ | 293 | 357 | 421 | 485 | 550 | 614 | 678 | 743 | 807 | 871 | 935 | 1064 | 1193 | 1321 | 1450 | 21.47 | 49.3 |
| 1¼ | 313 | 382 | 451 | 520 | 589 | 657 | 726 | 795 | 864 | 933 | 1002 | 1140 | 1278 | 1416 | 1554 | 22.90 | 53 |
| 1⅜ | 333 | 406 | 480 | 553 | 629 | 702 | 776 | 849 | 923 | 996 | 1070 | 1217 | 1364 | 1511 | 1658 | 24.48 | 56.5 |
| 1 | 351 | 429 | 507 | 585 | 663 | 741 | 819 | 897 | 975 | 1053 | 1131 | 1287 | 1443 | 1599 | 1755 | 26.0 | 60. |
| 1⅛ | 371 | 453 | 536 | 618 | 701 | 783 | 865 | 948 | 1031 | 1113 | 1196 | 1361 | 1526 | 1691 | 1856 | 27.48 | 63.5 |
| 1½ | 389 | 476 | 563 | 650 | 737 | 824 | 911 | 998 | 1085 | 1172 | 1259 | 1432 | 1606 | 1780 | 1954 | 28.98 | 67 |

**6x6**

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 108 | 129 | 151 | 173 | 194 | 216 | 237 | 259 | 281 | 302 | 324 | 367 | 410 | 453 | 496 | 7.2 | 17.4 |
| ⅝ | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 | 425 | 475 | 525 | 575 | 8.36 | 20.2 |
| ¾ | 141 | 169 | 198 | 226 | 255 | 283 | 312 | 340 | 369 | 397 | 426 | 483 | 540 | 597 | 655 | 9.5 | 23 |
| ⅞ | 157 | 189 | 221 | 253 | 285 | 317 | 349 | 380 | 412 | 444 | 476 | 541 | 605 | 669 | 732 | 10.62 | 25.7 |
| 1 | 173 | 208 | 243 | 278 | 313 | 348 | 383 | 418 | 454 | 489 | 524 | 595 | 665 | 736 | 806 | 11.70 | 28.4 |
| 1⅛ | 189 | 228 | 266 | 304 | 343 | 381 | 420 | 458 | 496 | 535 | 573 | 650 | 727 | 803 | 880 | 12.8 | 31.1 |
| 1¼ | 205 | 246 | 288 | 330 | 371 | 413 | 454 | 495 | 538 | 579 | 621 | 704 | 787 | 871 | 954 | 13.88 | 33.7 |
| 1⅜ | 218 | 263 | 308 | 353 | 398 | 442 | 487 | 532 | 577 | 622 | 666 | 756 | 846 | 935 | 1025 | 14.94 | 36.4 |
| 1½ | 233 | 281 | 329 | 377 | 425 | 473 | 521 | 563 | 616 | 664 | 712 | 807 | 902 | 998 | 1094 | 15.96 | 39 |
| 1⅝ | 248 | 299 | 350 | 401 | 452 | 503 | 554 | 605 | 656 | 707 | 758 | 860 | 961 | 1063 | 1165 | 16.98 | 41.5 |
| 1 | 262 | 316 | 370 | 424 | 478 | 532 | 586 | 640 | 694 | 748 | 802 | 910 | 1018 | 1126 | 1234 | 18.0 | 44 |

**6x4**

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 94 | 111 | 128 | 145 | 162 | 179 | 197 | 214 | 231 | 248 | 265 | 300 | 334 | 368 | 403 | 5.7 | 14.4 |
| ⅝ | 108 | 128 | 148 | 167 | 187 | 207 | 227 | 247 | 267 | 286 | 306 | 346 | 386 | 425 | 465 | 6.6 | 16.7 |
| ¾ | 122 | 144 | 167 | 190 | 212 | 235 | 257 | 280 | 302 | 325 | 347 | 392 | 437 | 482 | 527 | 7.5 | 19 |
| ⅞ | 136 | 161 | 186 | 211 | 236 | 261 | 287 | 312 | 337 | 362 | 387 | 437 | 487 | 538 | 588 | 8.38 | 21.2 |
| 1 | 150 | 177 | 205 | 232 | 260 | 288 | 315 | 344 | 371 | 398 | 426 | 481 | 537 | 592 | 647 | 9.20 | 23.4 |
| 1⅛ | 163 | 193 | 223 | 253 | 283 | 313 | 344 | 374 | 404 | 434 | 465 | 525 | 585 | 646 | 706 | 10.06 | 25.6 |
| 1¼ | 175 | 207 | 240 | 273 | 306 | 338 | 371 | 404 | 436 | 469 | 501 | 567 | 632 | 697 | 763 | 10.88 | 27.7 |
| 1⅜ | 188 | 223 | 258 | 293 | 328 | 363 | 397 | 432 | 467 | 502 | 537 | 607 | 678 | 748 | 819 | 11.70 | 29.8 |
| 1½ | 200 | 238 | 275 | 312 | 350 | 387 | 424 | 462 | 499 | 537 | 574 | 649 | 723 | 799 | 874 | 12.46 | 32 |
| 1⅝ | 212 | 251 | 291 | 331 | 371 | 410 | 450 | 490 | 530 | 570 | 609 | 689 | 768 | 848 | 927 | 13.24 | 34 |
| 1 | 224 | 266 | 308 | 350 | 392 | 434 | 476 | 518 | 560 | 602 | 644 | 728 | 812 | 896 | 980 | 14.0 | 36 |

**5x3½**

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 76 | 90 | 104 | 117 | 131 | 145 | 159 | 173 | 186 | 200 | 214 | 242 | 269 | 297 | 324 | 4.58 | 12.2 |
| ⅝ | 87 | 103 | 119 | 135 | 151 | 167 | 183 | 199 | 215 | 231 | 247 | 279 | 311 | 342 | 374 | 5.3 | 14.1 |
| ¾ | 99 | 117 | 135 | 153 | 171 | 189 | 207 | 225 | 243 | 261 | 279 | 315 | 351 | 387 | 423 | 6.0 | 16 |
| ⅞ | 110 | 130 | 150 | 170 | 190 | 210 | 230 | 250 | 270 | 290 | 310 | 350 | 390 | 430 | 470 | 6.7 | 17.3 |
| 1 | 120 | 142 | 164 | 186 | 208 | 230 | 252 | 274 | 296 | 138 | 340 | 384 | 428 | 472 | 516 | 7.32 | 19.7 |
| 1⅛ | 130 | 154 | 178 | 202 | 226 | 252 | 274 | 298 | 322 | 346 | 370 | 418 | 466 | 514 | 562 | 7.98 | 21.5 |
| 1¼ | 140 | 166 | 192 | 218 | 244 | 269 | 295 | 321 | 347 | 373 | 399 | 450 | 502 | 554 | 606 | 8.62 | 23.2 |
| 1⅜ | 149 | 177 | 205 | 233 | 261 | 289 | 316 | 344 | 372 | 400 | 427 | 483 | 538 | 594 | 649 | 9.26 | 25 |
| 1½ | 159 | 188 | 218 | 248 | 277 | 307 | 336 | 366 | 395 | 425 | 454 | 513 | 572 | 631 | 690 | 9.82 | 26.7 |

**4x4**

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 70 | 80 | 93 | 105 | 118 | 131 | 143 | 156 | 169 | 181 | 194 | 219 | 245 | 270 | 295 | 4.22 | 11.44 |
| ⅝ | 78 | 92 | 107 | 122 | 136 | 151 | 165 | 180 | 194 | 209 | 224 | 253 | 282 | 311 | 341 | 4.87 | 13.2 |
| ¾ | 87 | 103 | 120 | 136 | 153 | 169 | 186 | 202 | 219 | 235 | 252 | 285 | 318 | 351 | 384 | 5.5 | 15 |
| ⅞ | 96 | 115 | 133 | 155 | 170 | 188 | 206 | 225 | 243 | 261 | 280 | 316 | 352 | 390 | 427 | 6.11 | 16.7 |
| 1 | 106 | 126 | 146 | 167 | 187 | 207 | 227 | 247 | 267 | 288 | 308 | 348 | 388 | 429 | 469 | 6.72 | 18.4 |
| 1⅛ | 116 | 138 | 160 | 182 | 204 | 226 | 248 | 269 | 291 | 313 | 335 | 379 | 423 | 467 | 510 | 7.31 | 20.1 |
| 1¼ | 124 | 147 | 171 | 195 | 218 | 242 | 266 | 289 | 313 | 337 | 360 | 407 | 455 | 502 | 549 | 7.88 | 21.6 |
| 1⅜ | 134 | 158 | 183 | 208 | 233 | 259 | 284 | 309 | 334 | 360 | 385 | 436 | 486 | 537 | 587 | 8.43 | 23.4 |
| 1½ | | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | A′ | A″ |

**4x3**

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | A′ |
|---|---|---|---|---|---|---|---|---|
| ½ | 60 | 71 | 82 | 93 | 104 | 115 | 126 | 3.64 |
| ⅝ | 70 | 82 | 95 | 108 | 121 | 134 | 146 | 4.22 |
| ¾ | 79 | 93 | 107 | 121 | 135 | 150 | 164 | 4.74 |
| ⅞ | 87 | 103 | 119 | 135 | 151 | 166 | 182 | 5.28 |
| 1 | 95 | 113 | 130 | 147 | 146 | 181 | 199 | 5.76 |
| 1⅛ | 103 | 122 | 141 | 160 | 179 | 197 | 216 | 6.28 |
| 1¼ | 111 | 131 | 151 | 171 | 191 | 212 | 232 | 6.71 |

**3x3**

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | A′ |
|---|---|---|---|---|---|---|---|---|
| ½ | 47 | 56 | 65 | 74 | 83 | 91 | 100 | 2.9 |
| ⅝ | 55 | 65 | 75 | 85 | 95 | 105 | 115 | 3.34 |
| ¾ | 62 | 73 | 84 | 95 | 106 | 117 | 129 | 3.74 |
| ⅞ | 67 | 80 | 93 | 105 | 118 | 130 | 143 | 2.16 |
| 1 | 75 | 88 | 101 | 114 | 128 | 141 | 155 | 4.52 |

ing 50 to 100 tons is weighed by scale and placed on board, the gages being read at intervals and the averages taken. The displacement for known weights of stone is thus determined, and tables showing the tonnage of the scow for every 0.005 ft. of displacement are made. Thereafter the difference of the "light reading" and the "loaded reading" referred to the table gives at once the tons of stone on the scow. It will be evident that to insure accuracy in the use of this method the vessel must be kept closely on an even keel.

**Misadventures of a Civil Engineer**—In recent discussions in the columns of Engineering News of the compensation and professional status of engineers more or less odious comparisons have been made with the legal profession. A concrete example of the superiority of the latter profession is to be found in an incident which occurred in New York City, on Oct. 1, last. A well known engineer of the Department of Gas, Water Supply and Electricity was superintending repairs to a water main in front of one of the city's numerous police courts. The magistrate objected to the noise made in the repair work and sent forth representatives of the strong arm of the law to arrest the unfortunate man in charge. The latter, the above mentioned engineer, declares that he was haled into the court room and that the magistrate had him locked up in the prison pen for an hour, finally releasing him after a severe upbraiding. Our brother engineer has brought suit for $25,000 against the unkind magistrate for "an act of tyranny and oppression utterly unwarranted by law."

## Volumes of Prismoidal Tanks

For computing partial volumes of rectangular tanks or reservoirs having sloping sides, Douglas McLean, Coolgardie, West Australia, recommends the method of constant second differences. Dividing the tank into zones or layers of equal height, the difference between the content of one zone and the content of the zone next below is the first difference; the difference between two successive first differences is the second difference. The second difference is constant for a tank of the shape mentioned. To apply this fact, calculate the volume of three successive zones, find the first differences and the second difference, and add the latter successively to the first differences, thus obtaining all the first differences. The latter, added to the volumes already calculated, will give all the zone volumes.

A little calculation will be saved by using the formula for the second difference:

$$D'' = 8\,mnh^3$$

in which $h$ is the depth of the zone, $m$ is the ratio $\frac{\text{horizontal}}{\text{vertical}}$ for the side slopes, and $n$ is the corresponding ratio for the end slopes.

EXAMPLE — Rectangular reservoir with side and end slopes 1 on 2; bottom dimensions 286x135 ft.; depth 14 ft.; find the contents of zones 6 in. deep.

Here $m = n = 2$, and $h = \frac{1}{2}$, so that $D'' = 8 \times 4 \times \frac{1}{8} = 4$ cu.ft. Computing the volumes of the two lowest zones, we get 19,516.17 and 19,941.17, with a first difference of 425. Then the successive first differences are 425, 429, 433, 437, etc. The volumes are then found.

| Zone | Second diffs. | First diffs. | Volumes |
|---|---|---|---|
| 0 — ½ | 4.00 | ... | 19,516.17 |
| ½ — 1 | Constant | 425 | 19,941.17 |
| 1 — 1½ | .... | 429 | 20,370.17 |
| 1½ — 2 | .... | 433 | 20,803.17 |
| 2 — 2½ | .... | 437 | 21,240.17 |
| 2½ — 3 | .... | 441 | 21,681.17 |
| etc. | | | etc. |

Precisely the same method of calculation applies to conical tanks, i.e., circular tanks with sloping sides, except that the second-difference formula is slightly different. Calling $m$ the side slope $\frac{\text{horizontal}}{\text{vertical}}$ and $h$ the depth of zone, the formula is

$$D'' = 2\pi m^2h^3 = 6.283\,m^2h^3$$

which is constant.

## Plate-Girder Tables

The tables presented herewith, prepared by O. von Voigtlander, of the designing department of the Public Service Commission, New York City, are intended for assistance in the work of designing plate-girders of heavy section, especially where the use of cover-plates shifts the center of gravity of the flange quite materially from its normal position, and the estimation of effective depth is, therefore, uncertain. The tables give separately the section moduli of the angles and of the cover-plates, for various depths back to back of angles, and for various sizes of angles and plates. They are believed to cover practically the entire range of girders commonly required, and the inclusion of the smaller depths permits also of using the table for moment calculations in the case of heavy columns exposed to bending, etc.

The design of a plate-girder to suit a given maximum bending moment is usually a process of trial and error; unless the designer has had much experience to draw upon, quite a bit of time may be wasted before the most satisfactory arrangement of depth, size of angles and width and thickness of cover-plates has been decided upon. When the tables are used, however, it is only necessary to divide the maximum bending moment in inch-pounds by the allowed unit-stress, thus obtaining the required section modulus, and then use the tables to find what make-up will best give this section modulus.

In Table I the left half gives the section moduli of angles when used in girders having no cover-plates; one rivet hole per angle is deducted. The right half gives the same quantity for the angles of girders having cover-plates, two rivet holes per angle being deducted; the effective depth of the girder is greater than in the first case, because of the addition of the cover-plates. The use of a greater effective depth and the deduction of one more rivet hole make the figures of the right half of the table different from those of the left half. Table II gives the section moduli for cover-plates of girders, the effective depth employed being in each case the same as that used in the right half of Table I; two rivet holes are deducted from the section of the plate. It is to be understood that the section moduli are for two cover-plates, one in each flange. The range of plate widths is from 20 in. to 8 in., which should prove sufficient for nearly all girder calculations.

Web calculations are facilitated by Table III, which gives the shearing value of plates of various widths and thicknesses, in thousands of pounds, for a unit-shear of 10,000 lb. per sq.in. Alongside of this is given in Table IV the moment capacity of web-plates, counting one-eighth of the web as flange area, in accordance with usual practice.

Various other calculations are facilitated by the figures for areas and weights, included in Tables I and II. In the table of angles, Table I, the column headed $A$ gives the net area of two angles and the column headed $W$ gives the weight of four angles per foot of length. In the cover-plate table, Table II, the column headed $a$ gives the net area of one plate in square inches, and the column $w$ gives the weight of two plates (one in each flange) per foot of length.

The gross area of the web can be obtained from Table III by pointing off one place from the right. Thus, for 24-in. web, ¼ in. thick, the table gives the value 180; the area is 18.

Tables I and II are based on a distance back to back of angles ¼ in. greater than the nominal depth, i.e., for 24-in. girders the angles were taken to be 24¼ in. back to back.

EXAMPLE—Maximum bending moment = 32,000,000 in.-lb.; maximum shear = 840,000 lb. Design for flange stress of 16,000 lb. per sq.in. and web shear of 12,000. No metal to be thicker than ⅞ in. Outside conditions dictate a girder depth of 36 in.

The bending moment and the allowed flange stress call for a section modulus

$$\frac{32{,}000{,}000}{16{,}000} = 2{,}000$$

Using Table I, right half ("With Covers"), we find that 8x8x⅞-in. angles give a section modulus for 36 in. depth of 726. Then cover-plates must be provided for 2000 — 726 = 1274. Taking a width of 18 in., we find from Table II that 2⅛-in. thickness of plates is required in each flange.

For web thickness, enter Table III with the value $\frac{1}{12} \times 840 = 700$; the required thickness is found to be 1$\frac{1}{16}$ in., or a 1⅛-in. web with two ⅞-in. side plates. If one-eighth of the web is counted as flange, its modulus is 115 (see Table IV). This allows decreasing the flange cover-plates to 1⅞-in. thickness.

## TABLE II. SECTION MODULI, AREAS AND WEIGHTS OF COVER-PLATES, FOR PLATE-GIRDERS

The figures in the tables are for cover-plates in each flange. The figures over tables denote widths of cover-plates, in inches. Column headings denote nominal girder depths, in inches. Column a gives net area of one plate, two rivet-holes deducted. Column w gives weight of two plates, lb. per lin. ft. (Weight of girder = W + w + 0.34 T, where T is the tabular web-shear value, Table IID.

### 20″

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | a | w |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | 126 | 146 | 166 | 187 | 207 | 227 | 247 | 268 | 288 | 308 | 328 | 369 | 409 | 450 | 490 | 6.75 | 51. |
| 5/16 | 147 | 170 | 194 | 218 | 241 | 265 | 289 | 313 | 336 | 360 | 383 | 430 | 478 | 525 | 572 | 7.89 | 59.5 |
| ⅜ | 159 | 186 | 213 | 250 | 277 | 304 | 331 | 358 | 385 | 412 | 439 | 493 | 547 | 601 | 655 | 9.0 | 68. |
| 7/16 | 192 | 222 | 252 | 281 | 312 | 342 | 373 | 403 | 434 | 464 | 495 | 555 | 616 | 677 | 738 | 10.13 | 76.5 |
| ½ | 211 | 245 | 279 | 313 | 347 | 381 | 414 | 448 | 482 | 516 | 549 | 617 | 685 | 752 | 819 | 11.25 | 85. |
| 9/16 | 234 | 271 | 308 | 346 | 383 | 420 | 457 | 495 | 531 | 569 | 606 | 680 | 754 | 829 | 903 | 12.38 | 93.5 |
| ⅝ | 255 | 296 | 337 | 378 | 418 | 459 | 499 | 540 | 580 | 621 | 661 | 742 | 823 | 904 | 985 | 13.5 | 102. |
| 11/16 | 283 | 325 | 367 | 410 | 452 | 492 | 542 | 586 | 630 | 673 | 718 | 805 | 893 | 981 | 1069 | 14.63 | 110.5 |
| ¾ | 302 | 349 | 396 | 443 | 490 | 538 | 585 | 632 | 679 | 727 | 774 | 868 | 963 | 1057 | 1152 | 15.75 | 119. |
| 13/16 | 324 | 375 | 425 | 475 | 526 | 576 | 628 | 679 | 729 | 779 | 830 | 931 | 1033 | 1134 | 1235 | 14.87 | 127.5 |
| 1 | 346 | 400 | 454 | 508 | 562 | 616 | 670 | 724 | 778 | 832 | 886 | 994 | 1102 | 1210 | 1318 | 18. | 136. |
| 1 1/16 | 366 | 425 | 484 | 543 | 599 | 657 | 713 | 771 | 828 | 886 | 943 | 1058 | 1172 | 1287 | 1401 | 19.12 | 144.5 |
| 1⅛ | 391 | 452 | 513 | 574 | 635 | 696 | 756 | 817 | 878 | 939 | 999 | 1121 | 1242 | 1364 | 1485 | 20.25 | 153. |
| 1 3/16 | 416 | 480 | 544 | 608 | 672 | 736 | 801 | 864 | 929 | 992 | 1057 | 1195 | 1314 | 1442 | 1570 | 21.37 | 161.5 |
| 1¼ | 440 | 507 | 574 | 641 | 709 | 776 | 844 | 911 | 979 | 1046 | 1114 | 1249 | 1384 | 1519 | 1654 | 22.5 | 170. |
| 1 5/16 | 461 | 532 | 603 | 675 | 745 | 817 | 887 | 958 | 1029 | 1100 | 1171 | 1312 | 1454 | 1596 | 1738 | 23.62 | 178.6 |
| 1⅜ | 486 | 560 | 634 | 709 | 783 | 857 | 931 | 1006 | 1080 | 1154 | 1228 | 1387 | 1525 | 1674 | 1822 | 24.75 | 187. |
| 1 7/16 | 508 | 586 | 661 | 742 | 820 | 898 | 975 | 1053 | 1130 | 1208 | 1285 | 1441 | 1596 | 1751 | 1906 | 25.87 | 195.5 |
| 1½ | 533 | 614 | 695 | 776 | 857 | 938 | 1019 | 1100 | 1181 | 1262 | 1343 | 1505 | 1667 | 1827 | 1991 | 27. | 204. |
| 1 9/16 | 587 | 675 | 756 | 844 | 932 | 1020 | 1107 | 1195 | 1283 | 1371 | 1458 | 1634 | 1809 | 1985 | 2160 | 29.26 | 221. |
| 1⅝ | 630 | 724 | 819 | 913 | 1008 | 1102 | 1197 | 1291 | 1386 | 1480 | 1575 | 1764 | 1953 | 2142 | 2331 | 31.5 | 238. |
| 1 11/16 | 679 | 781 | 882 | 983 | 1084 | 1186 | 1287 | 1388 | 1489 | 1591 | 1692 | 1894 | 2097 | 2299 | 2502 | 33.76 | 255. |
| 2 | 729 | 837 | 945 | 1053 | 1161 | 1269 | 1377 | 1485 | 1593 | 1701 | 1809 | 2025 | 2241 | 2457 | 2672 | 36. | 272. |
| 2⅛ | 779 | 894 | 1010 | 1123 | 1238 | 1353 | 1467 | 1582 | 1687 | 1802 | 1916 | 2138 | 2375 | 2605 | 2834 | 38.24 | 288. |
| 2¼ | 830 | 952 | 1073 | 1195 | 1316 | 1438 | 1558 | 1680 | 1801 | 1923 | 2044 | 2287 | 2530 | 2775 | 3016 | 40.5 | 306. |
| 2⅜ | 882 | 1010 | 1138 | 1267 | 1395 | 1523 | 1651 | 1780 | 1908 | 2036 | 2164 | 2421 | 2677 | 2934 | 3192 | 42.74 | 323. |
| 2½ | 934 | 1069 | 1204 | 1339 | 1474 | 1609 | 1744 | 1879 | 2014 | 2149 | 2284 | 2554 | 2824 | 3094 | 3364 | 45. | 340. |
| 2⅝ | 986 | 1128 | 1270 | 1411 | 1552 | 1695 | 1836 | 1978 | 2120 | 2262 | 2403 | 2687 | 2970 | 3254 | 3540 | 47.24 | 357. |
| 2¾ | 1039 | 1188 | 1336 | 1485 | 1633 | 1782 | 1930 | 2079 | 2227 | 2376 | 2522 | 2821 | 3118 | 3415 | 3710 | 49.5 | 374. |
| 2⅞ | 1093 | 1249 | 1404 | 1559 | 1714 | 1870 | 2025 | 2180 | 2337 | 2491 | 2646 | 2956 | 3267 | 3577 | 3890 | 51.74 | 391. |
| 3 | 1147 | 1309 | 1470 | 1633 | 1795 | 1957 | 2119 | 2281 | 2443 | 2605 | 2767 | 3091 | 3515 | 3739 | 4064 | 54. | 408. |

### 18″

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | a | w |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | 112 | 130 | 148 | 166 | 184 | 202 | 220 | 238 | 256 | 274 | 292 | 328 | 364 | 400 | 436 | 6. | 45.9 |
| 5/16 | 130 | 151 | 172 | 194 | 214 | 236 | 256 | 278 | 298 | 320 | 340 | 382 | 424 | 466 | 508 | 7. | 53.6 |
| ⅜ | 150 | 174 | 198 | 222 | 246 | 270 | 294 | 318 | 342 | 366 | 390 | 438 | 486 | 534 | 582 | 8. | 61.2 |
| 7/16 | 170 | 197 | 224 | 250 | 278 | 304 | 332 | 358 | 386 | 412 | 440 | 494 | 548 | 602 | 656 | 9. | 68.9 |
| ½ | 188 | 218 | 248 | 278 | 308 | 338 | 368 | 398 | 428 | 458 | 488 | 548 | 608 | 688 | 728 | 10. | 76.5 |
| 9/16 | 206 | 240 | 274 | 308 | 340 | 374 | 406 | 440 | 472 | 506 | 538 | 604 | 670 | 736 | 802 | 11. | 84.1 |
| ⅝ | 228 | 264 | 300 | 336 | 372 | 408 | 444 | 480 | 516 | 552 | 588 | 660 | 732 | 804 | 876 | 12. | 91.8 |
| 11/16 | 248 | 287 | 326 | 364 | 404 | 442 | 482 | 520 | 560 | 598 | 638 | 716 | 794 | 872 | 950 | 13. | 99.4 |
| ¾ | 268 | 310 | 352 | 394 | 436 | 478 | 520 | 562 | 604 | 646 | 688 | 772 | 856 | 940 | 1024 | 14. | 107.1 |
| 13/16 | 288 | 333 | 378 | 422 | 468 | 512 | 558 | 602 | 648 | 692 | 738 | 828 | 918 | 1008 | 1098 | 15. | 114.8 |
| 1 | 308 | 356 | 404 | 452 | 500 | 548 | 596 | 644 | 692 | 740 | 788 | 884 | 980 | 1076 | 1172 | 16. | 122.4 |
| 1 1/16 | 327 | 379 | 430 | 482 | 532 | 584 | 634 | 686 | 736 | 788 | 838 | 940 | 1042 | 1144 | 1246 | 17. | 130. |
| 1⅛ | 348 | 402 | 456 | 510 | 564 | 618 | 672 | 726 | 780 | 834 | 888 | 996 | 1104 | 1212 | 1320 | 18. | 13797 |
| 1 3/16 | 370 | 427 | 484 | 540 | 598 | 654 | 712 | 768 | 826 | 882 | 940 | 1054 | 1168 | 1282 | 1396 | 19. | 145.4 |
| 1¼ | 390 | 450 | 510 | 570 | 630 | 690 | 750 | 810 | 870 | 930 | 990 | 1110 | 1230 | 1350 | 1470 | 20. | 153. |
| 1 5/16 | 410 | 473 | 536 | 600 | 662 | 726 | 788 | 852 | 914 | 978 | 1040 | 1166 | 1292 | 1418 | 1544 | 21. | 160.7 |
| 1⅜ | 432 | 496 | 564 | 630 | 696 | 762 | 828 | 894 | 960 | 1026 | 1092 | 1224 | 1356 | 1488 | 1620 | 22. | 168.3 |
| 1 7/16 | 471 | 520 | 590 | 660 | 728 | 798 | 866 | 936 | 1004 | 1074 | 1142 | 1280 | 1418 | 1556 | 1694 | 23. | 176. |
| 1½ | 474 | 546 | 618 | 690 | 762 | 834 | 906 | 978 | 1050 | 1122 | 1194 | 1338 | 1482 | 1626 | 1770 | 24. | 183.6 |
| 1 9/16 | 516 | 594 | 672 | 750 | 828 | 906 | 984 | 1062 | 1140 | 1218 | 1296 | 1452 | 1608 | 1764 | 1920 | 26. | 198.9 |
| 1⅝ | 560 | 644 | 728 | 812 | 896 | 980 | 1064 | 1148 | 1232 | 1316 | 1400 | 1568 | 1736 | 1904 | 2072 | 28. | 214.7 |
| 1 11/16 | 604 | 674 | 784 | 874 | 964 | 1054 | 1144 | 1234 | 1324 | 1414 | 1504 | 1684 | 1864 | 2044 | 2224 | 30. | 229.5 |
| 2 | 648 | 744 | 820 | 936 | 1032 | 1128 | 1224 | 1320 | 1416 | 1512 | 1608 | 1800 | 1992 | 2184 | 2376 | 32. | 244.8 |
| 2⅛ | 692 | 794 | 896 | 998 | 1100 | 1202 | 1304 | 1406 | 1508 | 1610 | 1712 | 1916 | 2120 | 2324 | 2528 | 34. | 260.1 |
| 2¼ | 738 | 846 | 954 | 1062 | 1170 | 1279 | 1386 | 1494 | 1602 | 1710 | 1818 | 2034 | 2250 | 2470 | 2686 | 36. | 275.4 |
| 2⅜ | 784 | 898 | 1012 | 1126 | 1240 | 1354 | 1468 | 1582 | 1696 | 1810 | 1924 | 2152 | 2380 | 2608 | 2836 | 38. | 290.7 |
| 2½ | 830 | 950 | 1070 | 1190 | 1310 | 1430 | 1550 | 1670 | 1790 | 1910 | 2030 | 2270 | 2510 | 2750 | 2990 | 40. | 306. |
| 2⅝ | 876 | 1002 | 1128 | 1254 | 1380 | 1506 | 1632 | 1758 | 1884 | 2010 | 2136 | 2388 | 2640 | 2892 | 3144 | 42. | 321.3 |
| 2¾ | 924 | 1056 | 1188 | 1320 | 1452 | 1584 | 1716 | 1848 | 1780 | 2112 | 2244 | 2508 | 2772 | 3036 | 3300 | 44. | 336.6 |
| 2⅞ | 972 | 1110 | 1248 | 1386 | 1524 | 1662 | 1800 | 1938 | 2076 | 2214 | 2352 | 2628 | 2904 | 3180 | 3456 | 46. | 352. |
| 3 | 1020 | 1164 | 1308 | 1452 | 1796 | 1740 | 1884 | 2028 | 2172 | 2316 | 2460 | 2748 | 3036 | 3324 | 3612 | 48. | 367.2 |

### 16″

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | a | w |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | 97 | 113 | 129 | 145 | 161 | 177 | 192 | 208 | 224 | 240 | 255 | 287 | 318 | 350 | 381 | 5.25 | 40.8 |
| 5/16 | 115 | 133 | 151 | 169 | 188 | 206 | 224 | 243 | 261 | 279 | 298 | 334 | 371 | 408 | 445 | 6.13 | 47.6 |
| ⅜ | 131 | 152 | 173 | 194 | 215 | 236 | 257 | 278 | 299 | 320 | 341 | 383 | 425 | 467 | 509 | 7. | 54.4 |
| 7/16 | 150 | 173 | 196 | 219 | 243 | 266 | 290 | 314 | 337 | 360 | 384 | 431 | 479 | 526 | 574 | 7.88 | 61.2 |
| ½ | 165 | 191 | 217 | 244 | 270 | 296 | 322 | 349 | 375 | 401 | 427 | 480 | 532 | 586 | 638 | 8.76 | 68. |
| 9/16 | 182 | 211 | 240 | 269 | 298 | 327 | 355 | 385 | 413 | 442 | 471 | 529 | 586 | 644 | 702 | 9.62 | 74.8 |
| ⅝ | 201 | 232 | 263 | 294 | 325 | 357 | 388 | 420 | 451 | 483 | 514 | 577 | 640 | 703 | 766 | 10.5 | 81.6 |
| 11/16 | 217 | 251 | 285 | 319 | 353 | 387 | 422 | 455 | 490 | 524 | 558 | 626 | 695 | 763 | 832 | 11.38 | 88.4 |
| ¾ | 234 | 271 | 308 | 345 | 381 | 418 | 455 | 492 | 528 | 565 | 602 | 675 | 749 | 822 | 896 | 12.26 | 95.2 |
| 13/16 | 253 | 292 | 331 | 370 | 409 | 448 | 488 | 527 | 567 | 606 | 646 | 724 | 803 | 882 | 961 | 13.12 | 102. |
| 1 | 269 | 311 | 353 | 396 | 437 | 479 | 521 | 563 | 605 | 647 | 689 | 773 | 857 | 941 | 1025 | 14. | 108.8 |
| 1 1/16 | 286 | 331 | 376 | 421 | 466 | 511 | 555 | 600 | 644 | 689 | 733 | 823 | 912 | 1001 | 1090 | 14.88 | 115.6 |
| 1⅛ | 305 | 352 | 399 | 447 | 494 | 541 | 588 | 636 | 682 | 730 | 777 | 872 | 966 | 1061 | 1155 | 15.76 | 122.4 |
| 1 3/16 | 323 | 373 | 423 | 473 | 523 | 572 | 623 | 672 | 722 | 772 | 822 | 922 | 1022 | 1121 | 1221 | 16.62 | 129.2 |
| 1¼ | 340 | 393 | 446 | 499 | 551 | 604 | 656 | 709 | 761 | 814 | 866 | 971 | 1076 | 1181 | 1287 | 17.5 | 136. |
| 1 5/16 | 357 | 413 | 469 | 525 | 580 | 635 | 690 | 745 | 800 | 856 | 910 | 1021 | 1131 | 1241 | 1351 | 18.38 | 142.8 |
| 1⅜ | 377 | 435 | 493 | 551 | 609 | 667 | 724 | 782 | 840 | 890 | 955 | 1071 | 1186 | 1302 | 1417 | 19.28 | 149.6 |
| 1 7/16 | 397 | 457 | 517 | 577 | 637 | 698 | 758 | 819 | 879 | 940 | 1000 | 1120 | 1241 | 1362 | 1483 | 20.12 | 156.4 |
| 1½ | 415 | 478 | 541 | 604 | 667 | 730 | 793 | 856 | 919 | 982 | 1045 | 1171 | 1297 | 1423 | 1594 | 21. | 063.2 |
| 1 9/16 | 452 | 521 | 589 | 657 | 725 | 793 | 862 | 930 | 998 | 1066 | 1135 | 1271 | 1408 | 1544 | 1681 | 22.76 | 176.8 |
| 1⅝ | 490 | 563 | 637 | 710 | 784 | 857 | 931 | 1004 | 1078 | 1151 | 1225 | 1372 | 1519 | 1666 | 1813 | 24.52 | 190.4 |
| 1 11/16 | 528 | 607 | 686 | 765 | 843 | 922 | 1001 | 1080 | 1158 | 1237 | 1316 | 1473 | 1631 | 1788 | 1946 | 26.24 | 204. |
| 2 | 567 | 651 | 735 | 819 | 903 | 987 | 1071 | 1155 | 1239 | 1323 | 1407 | 1575 | 1743 | 1911 | 2079 | 28. | 217.6 |
| 2⅛ | 606 | 695 | 785 | 874 | 963 | 1052 | 1142 | 1231 | 1320 | 1409 | 1499 | 1677 | 1856 | 2034 | 2213 | 29.76 | 213. |
| 2¼ | 646 | 740 | 835 | 929 | 1024 | 1118 | 1213 | 1306 | 1401 | 1495 | 1590 | 1779 | 1968 | 2157 | 2346 | 31.52 | 244.8 |
| 2⅜ | 676 | 786 | 885 | 985 | 1085 | 1185 | 1284 | 1384 | 1484 | 1584 | 1683 | 1883 | 2082 | 2282 | 2481 | 33.24 | 258.4 |
| 2½ | 726 | 831 | 936 | 1041 | 1146 | 1251 | 1356 | 1461 | 1566 | 1671 | 1776 | 1986 | 2196 | 2406 | 2616 | 35. | 272. |
| 2⅝ | 767 | 877 | 988 | 1098 | 1208 | 1318 | 1429 | 1539 | 1649 | 1759 | 1870 | 2090 | 2311 | 2531 | 2751 | 36.76 | 285.6 |
| 2¾ | 808 | 924 | 1039 | 1155 | 1270 | 1386 | 1501 | 1617 | 1732 | 1848 | 1963 | 2194 | 2425 | 2656 | 2887 | 38.5 | 299.2 |
| 2⅞ | 850 | 971 | 1092 | 1213 | 1333 | 1454 | 1575 | 1696 | 1816 | 1937 | 2058 | 2299 | 2540 | 2782 | 3023 | 40.24 | 312.8 |
| 3 | 892 | 1018 | 1144 | 1270 | 1396 | 1522 | 1648 | 1774 | 1900 | 2026 | 2152 | 2404 | 2656 | 2908 | 3160 | 42. | 326.4 |

### 14″

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | a | w |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | 85 | 98 | 111 | 125 | 138 | 152 | 165 | 178 | 192 | 205 | 219 | 246 | 273 | 300 | 327 | 4.5 | 35.7 |
| 5/16 | 97 | 113 | 129 | 145 | 161 | 176 | 192 | 208 | 224 | 240 | 256 | 287 | 319 | 351 | 382 | 5.25 | 41.6 |
| ⅜ | 112 | 130 | 148 | 166 | 184 | 202 | 220 | 238 | 256 | 274 | 292 | 328 | 364 | 400 | 436 | 6. | 47.6 |
| 7/16 | 127 | 147 | 167 | 187 | 207 | 227 | 248 | 268 | 288 | 308 | 329 | 369 | 410 | 450 | 491 | 6.75 | 53.6 |
| ½ | 142 | 164 | 186 | 208 | 231 | 253 | 276 | 298 | 321 | 343 | 366 | 411 | 457 | 502 | 547 | 7.5 | 59.5 |
| 9/16 | 160 | 184 | 206 | 230 | 255 | 280 | 305 | 329 | 354 | 379 | 404 | 453 | 503 | 552 | 602 | 8.25 | 65.4 |
| ⅝ | 171 | 198 | 225 | 262 | 279 | 306 | 333 | 360 | 387 | 414 | 441 | 495 | 549 | 603 | 657 | 9. | 71.4 |
| 11/16 | 186 | 215 | 244 | 273 | 303 | 329 | 361 | 390 | 420 | 449 | 479 | 537 | 596 | 655 | 713 | 9.75 | 77.3 |
| ¾ | 202 | 233 | 264 | 295 | 327 | 359 | 390 | 421 | 453 | 484 | 516 | 579 | 642 | 705 | 768 | 10.5 | 83.8 |
| 13/16 | 218 | 251 | 284 | 317 | 351 | 375 | 419 | 452 | 486 | 519 | 553 | 621 | 688 | 755 | 823 | 11.25 | 89.3 |
| 1 | 231 | 267 | 303 | 339 | 375 | 411 | 447 | 483 | 519 | 555 | 591 | 663 | 734 | 680 | 878 | 12. | 95.2 |
| 1 1/16 | 247 | 285 | 323 | 361 | 399 | 437 | 476 | 514 | 552 | 590 | 628 | 705 | 781 | 857 | 934 | 12.75 | 101.1 |
| 1⅛ | 263 | 303 | 343 | 383 | 424 | 465 | 505 | 545 | 586 | 626 | 667 | 748 | 828 | 909 | 990 | 13.5 | 107.1 |
| 1 3/16 | 279 | 321 | 363 | 405 | 448 | 491 | 534 | 576 | 619 | 662 | 704 | 790 | 875 | 960 | 1045 | 14.25 | 113.1 |
| 1¼ | 293 | 338 | 383 | 428 | 473 | 518 | 563 | 608 | 653 | 698 | 743 | 833 | 922 | 1012 | 1102 | 15. | 119. |
| 1 5/16 | 309 | 356 | 403 | 450 | 497 | 544 | 591 | 638 | 685 | 732 | 779 | 873 | 968 | 1062 | 1156 | 15.75 | 124.9 |
| 1⅜ | 325 | 374 | 423 | 473 | 522 | 571 | 620 | 670 | 719 | 769 | 818 | 916 | 1015 | 1114 | 1212 | 16.5 | 130.9 |
| 1 7/16 | 341 | 392 | 443 | 494 | 546 | 597 | 649 | 700 | 752 | 803 | 855 | 958 | 1062 | 1165 | 1268 | 17.25 | 136.8 |
| 1½ | 358 | 411 | 464 | 517 | 571 | 624 | 679 | 732 | 786 | 839 | 894 | 1001 | 1109 | 1216 | 1324 | 18. | 142.8 |
| 1 9/16 | 387 | 446 | 505 | 563 | 622 | 680 | 739 | 797 | 856 | 914 | 973 | 1089 | 1206 | 1323 | 1440 | 19.5 | 154.7 |
| 1⅝ | 420 | 463 | 546 | 609 | 672 | 735 | 798 | 861 | 924 | 987 | 1050 | 1176 | 1302 | 1428 | 1554 | 21. | 166.6 |
| 1 11/16 | 453 | 520 | 588 | 655 | 723 | 790 | 858 | 925 | 993 | 1060 | 1128 | 1263 | 1398 | 1533 | 1668 | 22.5 | 178.5 |
| 2 | 486 | 558 | 630 | 702 | 774 | 846 | 918 | 990 | 1062 | 1134 | 1206 | 1350 | 1494 | 1638 | 1782 | 24. | 190.4 |
| 2⅛ | 519 | 596 | 672 | 749 | 825 | 902 | 978 | 1055 | 1131 | 1208 | 1284 | 1437 | 1590 | 1743 | 1896 | 25.5 | 202.3 |
| 2¼ | 553 | 634 | 715 | 796 | 877 | 958 | 1039 | 1120 | 1201 | 1282 | 1363 | 1525 | 1687 | 1849 | 2011 | 27. | 214.2 |
| 2⅜ | 598 | 673 | 759 | 844 | 930 | 1015 | 1101 | 1186 | 1272 | 1357 | 1443 | 1416 | 1785 | 1956 | 2128 | 28.5 | 226. |
| 2½ | 622 | 712 | 802 | 892 | 982 | 1072 | 1162 | 1252 | 1342 | 1432 | 1520 | 1700 | 1880 | 2060 | 2240 | 30. | 238. |
| 2⅝ | 657 | 752 | 846 | 941 | 1035 | 1130 | 1224 | 1319 | 1413 | 1509 | 1602 | 1791 | 1980 | 2169 | 2358 | 31.5 | 249.9 |
| 2¾ | 693 | 792 | 891 | 990 | 1089 | 1188 | 1287 | 1386 | 1485 | 1584 | 1683 | 1881 | 2079 | 2277 | 2475 | 33. | 261.8 |
| 2⅞ | 729 | 832 | 936 | 1039 | 1143 | 1246 | 1350 | 1453 | 1557 | 1660 | 1764 | 1971 | 2178 | 2385 | 2592 | 34.5 | 273.7 |
| 3 | 765 | 873 | 981 | 1089 | 1197 | 1305 | 1413 | 1521 | 1629 | 1737 | 1845 | 2061 | 2277 | 2493 | 2709 | 36. | 285.6 |

## TABLE II. SECTION MODULI, AREAS AND WEIGHTS OF COVER-PLATES FOR PLATE-GIRDERS—Continued

### 12″

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | a | w |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | 68 | 80 | 92 | 104 | 115 | 126 | 137 | 149 | 160 | 171 | 182 | 205 | 227 | 250 | 272 | 3.75 | 30.6 |
| 5/16 | 82 | 95 | 108 | 121 | 134 | 147 | 161 | 174 | 187 | 200 | 213 | 239 | 266 | 292 | 318 | 4.38 | 35.7 |
| ⅜ | 94 | 109 | 124 | 139 | 154 | 169 | 184 | 199 | 214 | 229 | 244 | 274 | 304 | 334 | 364 | 5. | 40.8 |
| 7/16 | 106 | 123 | 140 | 156 | 173 | 190 | 207 | 224 | 241 | 258 | 275 | 308 | 342 | 376 | 410 | 5.63 | 45.9 |
| ½ | 117 | 136 | 155 | 174 | 193 | 212 | 230 | 249 | 268 | 287 | 305 | 343 | 381 | 418 | 455 | 6.25 | 51. |
| 9/16 | 129 | 150 | 171 | 192 | 213 | 233 | 254 | 275 | 295 | 316 | 337 | 378 | 419 | 461 | 502 | 6.88 | 56.1 |
| ⅝ | 141 | 164 | 187 | 210 | 232 | 255 | 277 | 300 | 322 | 345 | 367 | 412 | 457 | 502 | 547 | 7.5 | 61.2 |
| 11/16 | 156 | 180 | 204 | 228 | 252 | 277 | 301 | 326 | 350 | 374 | 399 | 447 | 496 | 545 | 594 | 8.13 | 66.3 |
| ¾ | 168 | 194 | 220 | 246 | 272 | 299 | 325 | 351 | 377 | 404 | 430 | 482 | 535 | 587 | 640 | 8.75 | 71.4 |
| 13/16 | 180 | 208 | 236 | 264 | 292 | 320 | 349 | 377 | 405 | 433 | 461 | 517 | 574 | 630 | 686 | 9.38 | 76.5 |
| 1 | 192 | 222 | 252 | 282 | 312 | 342 | 372 | 402 | 432 | 462 | 492 | 552 | 612 | 672 | 732 | 10. | 81.6 |
| 1 1/16 | 205 | 237 | 269 | 301 | 333 | 365 | 396 | 428 | 460 | 492 | 524 | 588 | 651 | 715 | 778 | 10.63 | 86.7 |
| 1 1/8 | 217 | 251 | 285 | 319 | 353 | 387 | 420 | 454 | 488 | 522 | 555 | 623 | 690 | 758 | 825 | 11.25 | 91.8 |
| 1 3/16 | 230 | 266 | 302 | 338 | 373 | 409 | 445 | 480 | 516 | 551 | 587 | 658 | 730 | 801 | 872 | 11.88 | 96.9 |
| 1 ¼ | 245 | 282 | 319 | 356 | 394 | 431 | 469 | 506 | 544 | 581 | 619 | 694 | 769 | 844 | 919 | 12.5 | 102. |
| 1 5/16 | 256 | 295 | 335 | 375 | 414 | 454 | 493 | 532 | 572 | 611 | 651 | 729 | 808 | 887 | 966 | 13.13 | 107. |
| 1 ⅜ | 268 | 300 | 352 | 394 | 435 | 476 | 517 | 559 | 600 | 641 | 682 | 765 | 847 | 930 | 1012 | 13.75 | 112.2 |
| 1 7/16 | 283 | 326 | 369 | 412 | 456 | 499 | 542 | 585 | 628 | 671 | 714 | 801 | 887 | 973 | 1059 | 14.38 | 117.3 |
| 1 ½ | 294 | 341 | 386 | 431 | 476 | 521 | 566 | 611 | 656 | 701 | 746 | 836 | 926 | 1016 | 1106 | 15. | 122.4 |
| 1 9/16 | 329 | 378 | 420 | 469 | 518 | 567 | 615 | 664 | 713 | 762 | 810 | 908 | 1005 | 1103 | 1200 | 16.25 | 132.6 |
| 1 ⅝ | 350 | 402 | 455 | 507 | 560 | 612 | 665 | 717 | 770 | 822 | 875 | 980 | 1085 | 1190 | 1295 | 07.5 | 142.8 |
| 1 11/16 | 377 | 434 | 490 | 546 | 602 | 659 | 715 | 771 | 827 | 884 | 940 | 1052 | 1165 | 1277 | 1390 | 18.75 | 153. |
| 2 | 405 | 465 | 525 | 585 | 645 | 707 | 765 | 825 | 885 | 945 | 1005 | 1125 | 1245 | 1365 | 1485 | 20. | 163.2 |
| 2 1/16 | 433 | 497 | 560 | 624 | 688 | 752 | 815 | 879 | 933 | 997 | 1060 | 1188 | 1315 | 1443 | 1570 | 21.25 | 173.4 |
| 2 1/8 | 461 | 529 | 596 | 664 | 731 | 799 | 865 | 933 | 1000 | 1068 | 1135 | 1270 | 1405 | 1540 | 1675 | 22.5 | 183.6 |
| 2 3/16 | 490 | 561 | 632 | 704 | 775 | 846 | 917 | 989 | 1060 | 1131 | 1202 | 1345 | 1487 | 1630 | 1772 | 23.75 | 193.8 |
| 2 ¼ | 519 | 594 | 669 | 744 | 819 | 894 | 969 | 1044 | 1119 | 1194 | 1269 | 1419 | 1569 | 1719 | 1869 | 25. | 204. |
| 2 5/16 | 548 | 627 | 705 | 784 | 862 | 942 | 1020 | 1099 | 1178 | 1257 | 1335 | 1493 | 1650 | 1808 | 1965 | 26.25 | 214.2 |
| 2 ⅜ | 577 | 660 | 742 | 825 | 907 | 990 | 1072 | 1155 | 1237 | 1320 | 1402 | 1567 | 1732 | 1897 | 2062 | 27.5 | 224.4 |
| 2 7/16 | 607 | 694 | 780 | 686 | 952 | 1039 | 1125 | 1211 | 1297 | 1384 | 1470 | 1642 | 1815 | 1987 | 2160 | 28.75 | 234.6 |
| 3 | 637 | 727 | 807 | 907 | 997 | 1087 | 1177 | 1267 | 1357 | 1447 | 1537 | 1717 | 1897 | 2077 | 2257 | 30. | 244.8 |

### 10″

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 54 | 60 | 66 | 72 | a | w |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | 56 | 65 | 74 | 83 | 92 | 101 | 110 | 119 | 128 | 137 | 146 | 164 | 182 | 200 | 218 | 3. | 25.5 |
| 5/16 | 64 | 75 | 86 | 97 | 107 | 118 | 128 | 139 | 149 | 160 | 170 | 191 | 212 | 233 | 234 | 3.5 | 29.7 |
| ⅜ | 75 | 87 | 99 | 111 | 123 | 135 | 147 | 159 | 171 | 183 | 195 | 219 | 243 | 267 | 291 | 4. | 34. |
| 7/16 | 86 | 99 | 112 | 125 | 139 | 152 | 166 | 179 | 193 | 206 | 220 | 247 | 274 | 301 | 328 | 4.5 | 38.3 |
| ½ | 94 | 109 | 124 | 139 | 154 | 169 | 184 | 199 | 214 | 229 | 244 | 274 | 304 | 334 | 364 | 5. | 42.5 |
| 9/16 | 103 | 120 | 137 | 154 | 170 | 187 | 203 | 220 | 236 | 253 | 269 | 302 | 335 | 368 | 401 | 5.5 | 46.7 |
| ⅝ | 114 | 132 | 150 | 168 | 186 | 204 | 222 | 240 | 258 | 276 | 294 | 330 | 366 | 402 | 438 | 6. | 51. |
| 11/16 | 123 | 143 | 163 | 182 | 202 | 221 | 241 | 260 | 280 | 299 | 319 | 358 | 397 | 436 | 475 | 6.5 | 55.2 |
| ¾ | 134 | 155 | 176 | 197 | 218 | 239 | 260 | 281 | 302 | 323 | 344 | 386 | 428 | 470 | 512 | 7.5 | 59.5 |
| 13/16 | 145 | 167 | 189 | 211 | 234 | 256 | 279 | 301 | 324 | 346 | 369 | 414 | 459 | 504 | 549 | 7.5 | 63. |
| 1 | 154 | 178 | 202 | 226 | 250 | 274 | 298 | 322 | 346 | 370 | 394 | 442 | 490 | 538 | 586 | 8. | 68. |
| 1 1/16 | 163 | 189 | 215 | 241 | 266 | 292 | 317 | 343 | 368 | 394 | 419 | 470 | 521 | 572 | 623 | 8.5 | 72.2 |
| 1 1/8 | 174 | 201 | 228 | 255 | 282 | 309 | 336 | 363 | 390 | 417 | 444 | 498 | 552 | 606 | 660 | 9. | 76.5 |
| 1 3/16 | 186 | 214 | 242 | 270 | 299 | 327 | 356 | 384 | 413 | 441 | 470 | 527 | 584 | 641 | 698 | 9.5 | 80.7 |
| 1 ¼ | 195 | 225 | 255 | 285 | 315 | 345 | 375 | 405 | 435 | 465 | 495 | 555 | 615 | 675 | 735 | 10. | 85. |
| 1 5/16 | 204 | 236 | 268 | 300 | 331 | 363 | 394 | 426 | 457 | 489 | 520 | 583 | 646 | 709 | 772 | 10.5 | 89.3 |
| 1 ⅜ | 216 | 249 | 282 | 315 | 348 | 381 | 414 | 447 | 480 | 513 | 546 | 612 | 678 | 744 | 810 | 11.5 | 93.5 |
| 1 7/16 | 225 | 260 | 295 | 330 | 364 | 399 | 433 | 468 | 502 | 537 | 571 | 640 | 709 | 778 | 847 | 11.5 | 97.7 |
| 1 ½ | 237 | 273 | 309 | 345 | 381 | 417 | 453 | 489 | 525 | 561 | 597 | 669 | 741 | 813 | 885 | 12. | 102. |
| 1 9/16 | 258 | 297 | 336 | 375 | 414 | 453 | 492 | 531 | 570 | 609 | 648 | 726 | 804 | 882 | 960 | 13. | 110.5 |
| 1 ⅝ | 280 | 322 | 364 | 406 | 448 | 490 | 532 | 574 | 616 | 658 | 700 | 784 | 868 | 952 | 1036 | 14. | 119. |
| 1 11/16 | 302 | 347 | 392 | 437 | 482 | 524 | 572 | 617 | 662 | 707 | 752 | 842 | 932 | 1022 | 1112 | 15. | 127.5 |
| 2 | 324 | 372 | 420 | 468 | 516 | 564 | 612 | 660 | 708 | 756 | 804 | 900 | 996 | 1092 | 1188 | 16. | 136. |
| 2 1/16 | 346 | 397 | 448 | 499 | 550 | 601 | 652 | 703 | 754 | 805 | 856 | 958 | 1060 | 1162 | 1264 | 17. | 144.5 |
| 2 1/8 | 369 | 423 | 477 | 531 | 585 | 639 | 693 | 747 | 801 | 855 | 909 | 1017 | 1125 | 1235 | 1343 | 18. | 153. |
| 2 3/16 | 392 | 449 | 506 | 563 | 620 | 677 | 734 | 791 | 848 | 905 | 962 | 1076 | 1190 | 1304 | 1418 | 19. | 161.5 |
| 2 ¼ | 415 | 475 | 535 | 595 | 655 | 715 | 775 | 835 | 895 | 955 | 1015 | 1135 | 1255 | 1375 | 1495 | 20. | 170. |
| 2 5/16 | 438 | 501 | 564 | 627 | 690 | 753 | 816 | 879 | 942 | 1005 | 1068 | 1194 | 1320 | 1446 | 1572 | 21. | 178.6 |
| 2 ⅜ | 462 | 528 | 594 | 660 | 726 | 792 | 858 | 924 | 990 | 1056 | 1122 | 1254 | 1386 | 1518 | 1650 | 22. | 187. |
| 2 7/16 | 486 | 555 | 624 | 693 | 762 | 831 | 900 | 969 | 1038 | 1107 | 1176 | 1314 | 1452 | 1590 | 1728 | 23. | 195.5 |
| 3 | 510 | 582 | 654 | 726 | 798 | 870 | 942 | 1014 | 1086 | 1158 | 1230 | 1374 | 1518 | 1662 | 1806 | 24. | 204. |

### 8″

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 |
|---|---|---|---|---|---|---|---|
| ¼ | 41 | 48 | 55 | 62 | 69 | 76 | 82 |
| 5/16 | 49 | 57 | 65 | 72 | 80 | 88 | 96 |
| ⅜ | 56 | 65 | 74 | 83 | 92 | 101 | 110 |
| 7/16 | 64 | 74 | 64 | 94 | 104 | 114 | 124 |
| ½ | 71 | 82 | 93 | 105 | 116 | 127 | 138 |

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 |
|---|---|---|---|---|---|---|---|
| 9/16 | 79 | 91 | 103 | 115 | 128 | 140 | 152 |
| ⅝ | 87 | 100 | 113 | 126 | 139 | 153 | 166 |
| 11/16 | 93 | 108 | 122 | 137 | 151 | 166 | 181 |
| ¾ | 100 | 116 | 132 | 148 | 163 | 179 | 195 |
| 13/16 | 110 | 128 | 142 | 159 | 175 | 192 | 209 |

| | 18 | 21 | 24 | 27 | 30 | 33 | 36 |
|---|---|---|---|---|---|---|---|
| 1 | 117 | 133 | 151 | 170 | 187 | 205 | 223 |
| 1 1/8 | 131 | 151 | 171 | 192 | 212 | 232 | 252 |
| 1 ¼ | 145 | 168 | 191 | 214 | 236 | 259 | 281 |
| 1 ½ | 178 | 205 | 232 | 259 | 286 | 313 | 340 |

## TABLE III. SHEAR VALUES OF WEB-PLATES

In units of 1000 lb., for shearing stress of 10,000 lb. per sq. in.

| Depth of girder, In. | Thickness of web, in inches | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ¼ | 5/16 | ⅜ | 7/16 | ½ | 9/16 | ⅝ | 11/16 | ¾ | 1 | 1 1/16 | 1 1/8 | 1 3/16 | 1 ¼ | 1 5/16 | 1 ⅜ | 1 7/16 | 1 ½ | 1 9/16 | 1 ⅝ | 2 | 2 ¼ | 2 ½ | 2 ¾ | 2 ⅞ |
| 15 | 56 | 64 | 75 | 84 | 94 | 103 | 112 | 122 | 131 | | | | | | | | | | | | | | | | |
| 18 | 67 | 79 | 90 | 101 | 112 | 124 | 135 | 146 | 157 | 180 | 202 | 214 | 225 | 236 | 247 | 259 | 270 | 281 | 292 | 304 | 315 | 337 | 360 | 382 | 405 | 427 | 450 | 472 |
| 21 | 79 | 92 | 105 | 118 | 131 | 144 | 157 | 171 | 184 | 210 | 236 | 249 | 262 | 276 | 289 | 302 | 315 | 3.8 | 341 | 354 | 367 | 394 | 420 | 446 | 472 | 499 | 525 | 551 |
| 24 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 240 | 270 | 285 | 300 | 315 | 330 | 345 | 360 | 375 | 390 | 405 | 420 | 450 | 480 | 510 | 540 | 570 | 600 | 630 |
| 27 | 101 | 118 | 135 | 152 | 169 | 186 | 202 | 219 | 236 | 270 | 304 | 321 | 337 | 354 | 371 | 388 | 405 | 422 | 439 | 456 | 492 | 506 | 540 | 594 | 607 | 641 | 675 | 709 |
| 30 | 112 | 131 | 150 | 169 | 187 | 206 | 225 | 244 | 262 | 300 | 337 | 356 | 375 | 394 | 412 | 431 | 450 | 469 | 487 | 506 | 525 | 562 | 600 | 637 | 675 | 712 | 750 | 787 |
| 33 | 124 | 144 | 165 | 186 | 206 | 227 | 247 | 268 | 289 | 330 | 371 | 392 | 412 | 433 | 454 | 494 | 495 | 596 | 536 | 557 | 557 | 619 | 660 | 791 | 742 | 784 | 825 | 866 |
| 36 | 135 | 157 | 180 | 202 | 225 | 247 | 270 | 292 | 315 | 360 | 405 | 427 | 450 | 472 | 495 | 517 | 540 | 562 | 585 | 607 | 630 | 675 | 720 | 765 | 810 | 855 | 900 | 945 |
| 39 | 146 | 171 | 195 | 219 | 244 | 268 | 292 | 317 | 341 | 390 | 439 | 463 | 487 | 512 | 536 | 561 | 585 | 609 | 634 | 658 | 682 | 719 | 780 | 829 | 877 | 926 | 975 | 024 |
| 42 | 157 | 184 | 210 | 236 | 262 | 289 | 315 | 341 | 367 | 420 | 472 | 499 | 525 | 551 | 577 | 604 | 630 | 656 | 682 | 709 | 735 | 787 | 840 | 892 | 945 | 997 | 1050 | 1102 |
| 45 | 169 | 197 | 225 | 253 | 281 | 309 | 337 | 366 | 394 | 450 | 506 | 534 | 562 | 591 | 619 | 647 | 675 | 703 | 731 | 759 | 787 | 844 | 900 | 956 | 1012 | 1069 | 1125 | 1182 |
| 48 | 180 | 210 | 240 | 270 | 300 | 330 | 360 | 390 | 420 | 480 | 540 | 570 | 600 | 630 | 660 | 690 | 720 | 750 | 780 | 810 | 840 | 900 | 960 | 1020 | 1080 | 1140 | 1200 | 1260 |
| 54 | 202 | 236 | 270 | 364 | 337 | 371 | 405 | 439 | 472 | 540 | 607 | 641 | 675 | 709 | 742 | 776 | 810 | 844 | 877 | 911 | 945 | 1012 | 1080 | 1147 | 1215 | 1282 | 1350 | 1417 |
| 60 | 225 | 262 | 300 | 337 | 375 | 412 | 450 | 487 | 525 | 600 | 675 | 712 | 750 | 787 | 825 | 862 | 900 | 937 | 975 | 1012 | 1050 | 1125 | 1200 | 1275 | 1350 | 1425 | 1500 | 1575 |
| 66 | 247 | 289 | 330 | 371 | 412 | 454 | 495 | 536 | 577 | 660 | 742 | 784 | 825 | 866 | 907 | 949 | 990 | 1031 | 1072 | 1114 | 1155 | 1237 | 1320 | 1402 | 1485 | 1567 | 1650 | 1732 |
| 72 | 270 | 315 | 360 | 405 | 450 | 495 | 540 | 585 | 630 | 720 | 810 | 855 | 900 | 945 | 990 | 1035 | 1080 | 1125 | 1170 | 1215 | 1260 | 1350 | 1440 | 1530 | 1620 | 1710 | 1800 | 1890 |

## TABLE IV. EQUIVALENT SECTION MODULI OF WEB-PLATES

(One-eighth of web counted as flange area)

| Depth of girder, In. | Thickness of web, in inches | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ⅜ | 7/16 | ½ | 9/16 | ⅝ | 11/16 | ¾ | 13/16 | ⅞ |
| 15 | 9 | 11 | 12 | 14 | 15 | 17 | 18 | 20 | 21 |
| 18 | 13 | 15 | 18 | 20 | 22 | 24 | 26 | 29 | 31 |
| 21 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 |
| 24 | 24 | 28 | 31 | 35 | 39 | 43 | 47 | 51 | 55 |
| 27 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 |
| 30 | 37 | 43 | 49 | 55 | 61 | 67 | 74 | 80 | 86 |
| 33 | 45 | 52 | 59 | 67 | 74 | 82 | 89 | 97 | 104 |
| 36 | 53 | 62 | 71 | 80 | 89 | 98 | 106 | 115 | 124 |
| 39 | 62 | 73 | 83 | 93 | 104 | 114 | 125 | 135 | 146 |
| 42 | 72 | 84 | 96 | 108 | 120 | 132 | 144 | 157 | 169 |
| 45 | 83 | 97 | 111 | 124 | 138 | 152 | 166 | 180 | 194 |
| 48 | 94 | 110 | 126 | 142 | 158 | 173 | 189 | 205 | 221 |
| 54 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 |
| 60 | 148 | 173 | 197 | 222 | 246 | 271 | 296 | 320 | 345 |
| 66 | 178 | 208 | 238 | 267 | 297 | 327 | 357 | 387 | 417 |
| 72 | 213 | 248 | 284 | 319 | 354 | 390 | 426 | 461 | 498 |

# Letters to the Editor

## The Heaviest Locomotives

Sir—Will you be so good as to answer these two questions: (1) What is the weight of the largest locomotive in service, without its tender? (2) What is the distance between centers of the front and rear driving axles?

JOSEPH W. SHIPLEY.

Hyattsville, Md.
Dec. 27, 1911.

[The heaviest locomotives are the Mallet compounds of the 2-10-10-2 class on the Atchison, Topeka & Santa Fe Ry.; these weigh 308 tons (without tender) and have 225 tons on the driving wheels. Each group of five driving axles has a wheelbase of 19 ft. 9 in. The heaviest ordinary locomotives are the 2-10-2 engines of the same road; these weigh 143 tons (without tender), with 117 tons on the driving wheels and a driving wheelbase of 19 ft. 9 in.—ED.]

## Rainfall Data from Peru

Sir—I am inclosing you a small table showing the rainfall at the mine of the Aporoma Goldfields Ltd. for the past six months. This mine is located on the western slope of the Andes range, Province of Sandia, Peru:

| | |
|---|---|
| June | 7 in. |
| July | 6 " |
| August | 12 " |
| September | 5 " |
| October | 10 " |
| November | 18 " |
| Total | 60 " |
| Average per month | 10 " |
| Average per day | " |

This heavy precipitation is caused by the warm, moist winds from the montaña meeting with the cold air from the snow-covered peaks which lie within a few miles of the mine. It should be explained that the months of June, July, August and September are supposed to be in the dry season.

A. TRAVERS-EWELL,
Chief Engineer.

Aporoma Goldfields Ltd.,
Tirapata, Peru, S. A.
Dec. 2, 1911.

## Tests of Ballast on the Queensland Railways

Sir—I have been greatly interested in the articles appearing in your issue of Aug. 24, 1911, with regard to the thickness and quality of ballast required for a first-class railway. Some seven years ago, Mr. Lloyd Hassell, M. Inst. C. E., then under me in charge of maintenance on the Queensland Railways, conducted experiments on a small scale on the lines followed by the Pennsylvania R.R. This was not, however, for the purpose of ascertaining the thickness of ballast necessary to obtain a full bearing on the subsoil, but to ascertain what kind of ballast gave the most distribution; we were quite unable to afford to build lines of first-class quality, but relied on a relatively large number of sleepers and comparatively light loads to enable us to build and run lines to suit local conditions.

He found broken stone or other hard material to be the only thing which really spread the base of the loaded sleeper; gravel and sand did not do it. Carrying down the sides of the pyramids under sleepers (ties) at the observed angle of stability, I find, with sleepers spaced 1 ft. 3 in. apart, that the very least thickness of stone required to cover the whole formation is 18 in., and probably a little more.

Curiously enough, our experience has led us to the conclusion that two qualities of ballast are necessary on many of the soils, especially on clay or black soil. We now cover all our clay or black soil roads with about 4 or 5 in. of sand, and on this place whatever thickness of stone ballast we can afford to use. We find that this gives better results than either sand or stone alone.

W. PAGAN, M. Inst. C. E.,
Deputy Commissioner (and
lately Chief Engineer),
Queensland Railways.

Brisbane, Queensland.
Dec. 1, 1911.

[The experiments noted by Mr. Pagan endorse the opinion held by many engineers, and supported by the Pennsylvania R.R. tests, that the best and most economical method of ballasting track is to use a bed of sub-ballast independent of the ballast proper. This permits of using a smaller quantity of the ballast proper, the sub-ballast being of a cheaper material.—ED.]

## Earth Ballast and Rail Joints

Sir—There has been a discussion in our locating party as to the standard for earth (or dirt) ballasted track. Some claim that the rails should be laid with even joints instead of broken joints, and that in surfacing the track the earth should be up to the top of the rail head in center of track. I would like to find out which is the best way to lay track to be surfaced with earth, and the best way to surface it so as to get proper drainage.

E. R. WATKINS, JR.,
M., O. & G. Ry.

Okemah, Okla.
Dec. 29, 1911.

[As to rail joints, the most general practice on ballasted main tracks is to lay the rails with broken joints. Even joints are sometimes used on new lines not fully ballasted, as it is claimed that the track rides easier and requires less maintenance, as there are fewer low places; it is claimed further that with low joints on track having broken joints the wheels will be thrown laterally against the rails, tending to throw the track out of line. But with broken joints there is generally considered to be less liability of low joints, and many Western lines with comparatively light track prefer to lay the rails with broken joints. As stated in Tratman's "Railway Track and Track Work," the general opinion is strongly in favor of broken joints for all kinds of track, on the ground that they make a better riding track, hold line and surface better, and require less maintenance work.

As to earth or "dirt ballast," it is usual to fill this to a depth of 2 to 4 in. over the middle of the tie, and it should be given a uniform slope to the bottom of the end of the tie. On the Chicago & Eastern Illinois Ry., the earth is rounded up at the middle of the track to a height of 2 in. above the tie, sloping directly to the bottom of the tie and then a 1 on 10 slope to the edge of the bank. On the Atchison, Topeka & Santa Fe Ry., it is filled in 3 in. over the tie for a top width of 2 ft., then sloped to bottom of the tie, and a 1 on 8 slope to the edge of bank or toe of cut. In the book noted above, it is stated that if earth ballast is well put up when dry, it will go through a wet season fairly well, but, of course, it cannot be handled when wet. To keep earth-ballasted track in good condition, thorough drainage is necessary.—ED.]

## An Important Decision on the Engineer's Liability to the Contractor

Sir—In your issue of Nov. 23 is published an extremely interesting paper by Mr. C. A. Crane, secretary of the General Contractors' Association, which contains some remarks upon various forms of contracts used by municipalities.

He asks, in one place, whether the city should not assume the responsibility in

the event of the failure of a temporary structure, where the engineer reserves the right to approve or disapprove the plans. Exactly this question arose in the recent case of J. Hampton Moore, Receiver, v. the United States, and was decided by the U. S. Court of Claims. The contract there contained the following provisions:

> The contractors will . . . at their own risk and expense, furnish and provide . . . temporary structures of every description . . . necessary or requisite in and about the construction of said drydock . . . subject to the approval of the civil engineer.
>
> The works included in the contract will be carried out by the contractor under the inspection and supervision of the civil engineer detailed for the purpose, who will inspect all the materials and workmanship, and will have full authority to reject any which, in his opinion, are not in full accordance with the true spirit, intention and meaning of the contract, plans and specifications.

It became necessary to construct a temporary coffer-dam, and after considerable discussion of the subject between the engineer in charge for the United States and the contractors, and the rejection of two plans made by the contractors, the government engineer suggested a different plan of his own for the coffer-dam, and this was constructed by the contractors under the direction and approval of the engineer. This coffer-dam broke three times and the contractors claimed in the Court of Claims that they were entitled to charge the costs of repairing the breaches to the United States.

The Court of Claims declared that the exact question had not previously been decided in any government contract, and summarizes the rule of law proper to be found in the following language:

> We believe the rule in cases of this character to be that where a contractor constructs a work under a contract which provides that it shall be done under the direction and supervision of an engineer appointed by and under the employ of the owner, and loss occurs to such contractor by reason of defects in the plans directed to be followed by such engineer, of a character which ordinary skill would have foreseen, the owner should pay for such loss.

This is one of the cases where the equity and justice of the contractors' position impressed itself upon the court to such an extent as to lead the court to declare that the rule of law and the rule of justice were the same. The case has not yet been published in the reports of the Court of Claims, but will appear in Vol. 46, which will be issued in about one month.

WM. B. KING.

No. 728 Seventeenth St.,
Washington, D. C.
Dec. 28, 1911.

ET. 700 No c. Set JAN. 12.

## Conservation of Growing Timber in Massachusetts in the 17th Century

Sir—I recently came across, in the records of the Township of Sandwich, Mass., on Cape Cod, what appears to be one of the earliest attempts at "conservation of our natural resources" on record. I inclose an exact copy of the record, which may be of interest to your readers.

JAS. C. BOYD,
Consulting Engineer.

10 Bridge St., New York City.
Jan. 3, 1912.

August the 8, 1676.

Forasmuch as the Towne doeth judge it very disstructive to our young growing timber trees, for any person or persons to peill off the bark of any such trees—and the trees so peild either to lie and rotte or not to be serviceable for any other use but for fire—It is therefore enacted by the towne that noe person, either Taner or any other man in the Township of Sandwich, doe henceforth peil or cause to be peild any bark off any such young growing oake trees, except any such person that so peils trees, doe cut up such trees so peild for fire wood for his or their own use, and carry such wood home to theire owne houses within 2 months after any tree be so peild—and if any person that peiles of the bark of any oak tree or trees doe neglect to cutt and carry of the wood within 2 months after—shall forfeit twelve pence for the Towne use for every tree that any person peiles and doth not carry off as above said.

Nov. 10th 1653

It is ordered that noe man shall cut of any timber from the common, to sell it out of the town, or wrought either into wheeles, plancke or bordes upon ye forfeture of five shillings for every tree.

[With reference to the second item in the above record, it may be of interest to explain that in many of the towns organized in the Massachusetts Colony, certain tracts of land were set aside in the original settlement to be "common" land, which all residents of the town alike were equally entitled to use. It became necessary, however, almost at once to enact restrictions to prevent misuse of this common land, and the early town records are full of such restrictions.

As a sample of one of these early ordinances we print the following extract from the early records of the Town of Topsfield, in Essex County.—ED.]

At a lawful meeting of ye proprietors and Commoners of ye Towne of Topsfield ye 10th march 1696 or 7. it was ordered that no wood shall be fallen on ye south side of ye Riuer on ye common for fire wood and no trees shall be fallen on ye north side of ye Riuer in Topsfield common for fire wood under a foot and halfe ouer exsepting birch maple and popler on both sids of ye Riuer: and no timber to be fallen on either sids of ye Riuer with out leaue from ye maior parte of ye selectmen: and who so euer shall fall wood or timber contrary to ye orders aboue said shall pay ye some of ten shillings per tree to be recouered by ye selectmen: and euery one are to take notis if any fells trees contrary to the order aboue said: and thay are to informe ye selectmen: and ye informers shall haue halfe ye fine for thare paines ye other halfe of ye fines as aboue said to be disposed of as ye Towne shall giue order: and firther who euer haue liborty as aboue said for felling timber shall be inioyned totake ye whole top away in two months on ye pennallty for felling trees as aboue said to be recouered as aboue said: and these orders shall continew in force till ye propriorters shall pass firther orders on ye same acount.

## An Early Engineering News Poem

Sir—The writer was much pleased with the "Happy New Year" picture reproduced in ENGINEERING NEWS of Dec. 28, 1911. Could you make another concession to an old reader in the matter of reproductions? I would like very much to see again a picture and poem entitled, if I remember correctly, "The Rodman," and printed in 1887 or 1888.

A. L. DABNEY.

1716 Exchange Bldg.,
Memphis, Tenn., Jan. 6, 1912.

[We reproduce herewith the poem above referred to, entitled "Staking Out." It appeared 28 years ago, in ENGINEERING NEWS of Apr. 12, 1884, even longer ago than our correspondent suggested, so it will be new to most of our present readers. The illustration, like the New Year's one, was a sketch by D. McN. Stauffer.—ED.]

STAKING OUT

"What is that, Mother?" "The Rodman, my child.
His footsteps are weary, his accents are wild;
His hair, how disordered! His eyeballs how blear!
And see where his necktie hangs under his ear."

"Rod up there! Hold her steady!! Go down the hill!!!
7.8 Cut 2.2—No, begosh, it's a fill.
Half the roadbed: 13 : the slope 1:1;
No, it's 1½ though, as sure as a gun.
Well, that makes—let's see—O! Stick her in there.
It'll do. Perhaps the contractor will swear.
But no difference: We're the big dog in this fight.
No matter what's wrong, just swear it's all right.
A contractor don't know a beefstake from a bone.
Now pick up your tools, and let's pull out for home."

J. H. K. B.,
Laurel Hill Swamp Angel.
From the S. P. R. R. "Transit."

## Bottles vs. Field Books!

Sir—Referring to the illustration "A Happy New Year" on your editorial page of Dec. 28: My engineering experience began in the year 1888 in the sunny South and Jack Frost did not trouble us as he did the surveyor in your sketch. I am, therefore, unable to say whether or not the bottle in the man's pocket typifies

a characteristic of the engineering profession prior to that time. In the 23 years of my experience I have never noticed that the field engineer had a spare pocket for a bottle after he had taken care of his field books. I do not believe that a bottle of "booze" is now a typical part of an engineer's "Happy New Year."

Yours truly,

J. L. CAMPBELL.

El Paso, Tex., Jan. 2, 1912.

[Neither do we.—ED.]

## Rapid Destruction of Timber Beams from Dry Rot

Sir—The article on "Rapid Destruction of Timber Beams from Dry Rot," from a report on a cotton mill made by Messrs. C. F. Smith and F. J. Hoxie, in the issue of ENGINEERING NEWS for Dec. 21, brings up a very important question in regard to the species and quality of timber sold under the commercial name of longleaf pine. As true longleaf becomes scarcer and of higher price, it is inevitable that other species of pine common in the South will be substituted. When this is done without the knowledge or consent of the buyer, disastrous results such as described will follow.

Where preservative treatment is given and a limit placed on the number of annual rings per inch, so that the requisite strength is obtained, the mixture of species is not so serious. Since, however, much pine timber will continue to be used in situations where treatment is not given, some classification which will assure the consumer of getting what is needed or desired for a particular purpose should be worked out. In England and some other European countries, a definite classification of species is made by using the botanical names; but, unfortunately, in our South Atlantic states there are so many different species of pine, and the lumbermen have given so little attention to their botanical characteristics, that a classification based on the Latin names would be out of the question. For the present the specifications covering the percentage of heart and the number of rings per inch seem to be the only protection which the consumer can secure.

In the article referred to, loblolly and Cuban pine are classed together as unsuitable for use in important structures without treatment; and it is stated that these two pines are similar in the structure of the wood. Foresters will question this statement because the loblolly and Cuban pines, in their optimum range, differ very materially in the structure of the wood, the former having a very large percentage of sap, broad rings of growth, and a lighter color and of lighter weight than Cuban.

Probably less is known definitely regarding Cuban than any of the other pines, but it is certain, from present knowledge, that, although the tree varies in its characteristics in different parts of its range, it is, generally speaking, stronger and heavier than true longleaf, is nearly all heartwood, and will resist decay very much better than loblolly or shortleaf. As the southern part of its range is approached, in south central Florida, the wood becomes heavier and more resinous in nature, and may be expected to give fully as long life as longleaf.

In the concluding paragraph of the article it is stated that "it is difficult, if not impossible, to distinguish the heart wood in much of this material, and much of this material has no heart wood." Here, again, loblolly and Cuban pine cannot be broadly grouped, for while loblolly may have little or no heart wood, and the heart not always clearly distinguished by its resinous content, although it can be recognized by its color, Cuban pine has a very distinct differentiation between heart and sap. It should also be remembered that these are not the only two species which may be sold as "longleaf," the pond, and even shortleaf pine, and others, coming into the market under confusing trade names.

E. A. STERLING,

Forester, Pennsylvania R.R.

Philadelphia, Penn., Jan. 2, 1912.

## What Is a Civil Engineer?

Sir—At irregular intervals there appear in your columns letters about the status of the engineer and the compensation that is his due. Mr. Bagley, in your issue of Dec. 14, has touched the keynote, I think, in referring to the man who was "a locomotive engineer, a stationary engineer, a hoisting engineer, and a civil engineer, too."

And here is the trouble: We call ourselves engineers, but we never shall be recognized by the world as a profession so long as we are confused, in the popular mind, with another class little above laborers, who are also called engineers.

I do not wish to disparage their honest work, but let it be accepted at its face value. Almost any farmhand can learn to run a steam or gasoline engine; and if he does this to any great extent, he will soon be called an engineer. Such is the popular qualification for the distinction.

People rarely see a real engineer in his office; they do not know of the hours spent in mathematical calculations, or of the book knowledge that must be his; they see him only in the field doing what seems to them to be easy, although perhaps a kind of skilled, labor. Hence they class him with the hoisting engineer, although they may doubt *his* ability to understand hoisting machinery. Who is willing to pay the civil engineer $10 a day when his equal in rank, the hoisting engineer, gets $3?

To an outsider, construction is often all that can be seen of engineering, and he considers the men engaged in it, as the latter frequently regard themselves, engineers. Witness the case of the foreman who signed his weekly reports, "Patrick Murphy, S. I." Curiosity and investigation on the part of the office staff revealed the fact that "S. I." stood for "Sivil Ingineer." Like the man in Aldrich's story, we wonder what an uncivil one is like.

Disagreeing, as we do, among ourselves as to what constitutes an engineer, other people who are little aware of these distinctions of ours can only accept a man at his own rating. Thus any employee in surveying or construction may style himself an engineer. Too often we see men whose competence as civil engineers may be justly questioned, calling themselves consulting engineers.

The college man is a factor in reducing the compensation in all these cases. It is no fault of his, but rather the unprincipled attempts of others to take advantage of his impoverishment. Four years in a technical course require an expenditure of several thousand dollars, and often leave the mature graduate stranded. Often from necessity he must take employment at merely a living wage.

Among employers who are willing to give only as much as the market requires, this can only result in lowering the wages all the way along the line. Men who have spent the best years of their lives in preparing for a profession, and have spent money worth more to them at that period than at any other time of their lives, should be conceded a nobility of purpose that deserves a far better reward.

It must be gratifying to these to see that a new word is coming into use, i.e., "Graduate Engineer." Slowly the public is beginning to realize the part that these men play in the progress of the times. They are the ones on whom the secure standing of the profession depends.

The question, "What is a civil engineer?" still remains. Surveying is not engineering; the word engineer does not necessarily imply association with engines; the word civil does not necessarily mean municipal. These differences must be taught the public before it will give us the respect due a profession.

One difficulty lies in the fact that an engineering staff is like an army, from chief down to the laborer, as from general to private. How many of them are engineers, and where shall the line be drawn as between officer and private?

The term civil engineer has been abused, and as there is no restriction to its use, popularly it means nothing. The burden of both fault and solution lies

with us. If we do not remedy it nobody will, except in a way that will cause us to be ashamed of—legislation for public security against inefficient engineering!

A. W. BEDELL.

Chappaqua, N. Y.
Jan. 2, 1912.

## Sewage Clarification and Sludge Treatment at Elberfeld, Germany

Sir—Your issue of Dec. 28, 1911, contains an article by Emil Kuichling entitled "Recent Methods of Sewage Clarification and Sludge Treatment in Germany," in which he discusses a paper on the sewage-disposal works of Elberfeld, Germany, read at the Convention of Municipal Engineers, held in Elberfeld, Sept. 13, 1910, by Mr. Schönfelder, city engineer of that city, and published in the *Technisches Gemeindeblatt* for Oct. 20 and Nov. 5, 1910.

The Elberfeld sewage-disposal works, which have been in operation since 1907, treat the sewage of the two cities of Barmen and Elberfeld, having a combined population of 250,000 people. The sewers are, for the most part, built on the separate system, the sewage amounting to about 60 gal. per capita daily, including a large percentage of trades waste. It is strong and quite fresh on reaching the works, which include grit chambers, revolving screens and shallow settling tanks, provided with hopper bottoms and pipes for removal of the sludge under water. Mr. Schönfelder, in his paper, not only emphasizes certain of the advantages claimed for this type of settling tank, but criticizes the so-called Imhoff, or Emscher, sewage settling tanks. The writer, after spending a year in the employment of the Emscher Genossenschaft and studying the disposal works built and operated by that commission, visited the Elberfeld works in company with Richard H. Gould, of Boston, Mass., on July 22, 1911, and talked with the works manager. He has, therefore, been especially interested in reading Mr. Kuichling's article, and wishes to give a brief account of his visit to the works and to discuss one or two of the criticisms of the Imhoff type of tank.

In the first place, it is suggested in Mr. Kuichling's article that the Imhoff tanks are not and cannot be easily built so as to give the best sedimentation, because of the fact that the cross-section of the settling chambers at its intersection with the cylindrical walls of the tanks is so shallow that the continuous horizontal forward movement of the water is interfered with. This is true only to a very limited extent. At the plant in Essen North, for example, where the settling chamber extends over three sludge wells, the chamber is about 100 ft. long, 23 ft. wide, and at its shallowest point, 9 ft. deep, or 0.5 ft. greater than the depth of sewage in the Elberfeld tanks, measured from the surface of the liquid to the tops of the hopper bottoms. The writer observed, during his visit to the Elberfeld works, that the clarification effected was not any better, in fact not as good, as that ordinarily obtained at the various works of the Emscher Genossenschaft, which consist of stationary screens, grit chambers and Imhoff tanks.

The Elberfeld tanks are said to have been designed with special reference to the easy removal of the sludge in a fresh condition at intervals frequent enough to prevent decomposition of the deposits which would "spoil" the sludge and tend to make the effluent of the tanks septic. According to the works manager, it proved impracticable to remove the sludge easily or completely from the hopper bottoms under water, on account of the way it stuck to the sides of the hoppers, and when I was there it was the practice to draw off the sewage standing above the sludge and then to flush the sludge into the pipe leading to the collecting well, from which it is forced by compressed air to the sludge lagoons. At the time of my visit there was considerable septic action going on in the tanks, the effluent of which had a slight septic odor, and the statement was made that, although the tanks were emptied each week, gas developed in the sludge deposits on the fourth or fifth day after the tanks were placed in operation.

Mr. Schönfelder apparently claims that the water content of the sludge removed from the Elberfeld tanks, given as about 90%, is as low as can possibly be obtained "in any other plant," which Mr. Kuichling interprets to mean, that the low water content claimed for the Imhoff tanks is not always attained. The experience of the writer has been that the sludge, removed from practically all of the full-sized plants in the Emscher district, contains less than 80% of water, and in some instances as little as 67%, which becomes reduced to 55% to 60% on the drying beds and, for instance, in Holzwickede, to less than 45%.

The quantity of sludge at Elberfeld, exclusive of screenings, containing 92% of water, is given as 235.4 cu.yd., from a daily sewage flow of 11,766,000 gal., corresponding to nearly 20 cu.yd. per 1,000,000 gal., or 750 cu.ft. per month per 1000 persons connected. By contrast, the sludge quantity obtained from the tanks at the works of the Emscher Genossenschaft, treating sewage of equal strength, is, for a separate system of sewers, less than 150 cu.ft. per 1000 persons per month, and this volume is further reduced 40% during drying on the sludge beds, which requires about one week, after which the total quantity to be handled is less than 90 cu.ft. per month per 1000 persons. The great difference in quantity of sludge obtained in Elberfeld and at the works of the Emscher Genossenschaft is due partly to the difference in the water content, the latter averaging only about 75% as compared with 92% at Elberfeld, and partly to the decomposition and gasification of the organic matter.

According to Mr. Kuichling's article, Mr. Schönfelder estimates the number of tanks of the Imhoff type which would be necessary to handle the sewage flow of Elberfeld (approximately 12,000,000 gal. per 24 hours), at 146, having an aggregate capacity of 224,236 cu.m. The Imhoff tanks at Essen North, which treat a daily flow of 17,000,000 gal. (almost 50% more) of strong sewage containing trades wastes, are only 18 in number, instead of 146, each 30 ft. in diameter and 33 ft. deep, the total capacity of the sludge chambers being only 6500 cu.m. below the slots. The Essen North plant was designed for a population of 200,000.

### DRYING OF SLUDGE

The number of open lagoons used at Elberfeld for drying the sludge is given as 24, and Mr. Kuichling states that:

> The sludge attains a spadeable consistency, with from 71% to 78% moisture, in the course of a few months, when it is removed to other localities in the vicinity and spread out on the surface of the ground to undergo further decomposition. Eventually it becomes a compact earthy mass which can be used for embankments and dikes. Some of the moist sludge is taken away by farmers for use as fertilizer and the remainder is applied with great success to the large tract of land owned by the city in the neighborhood of the plant.

Mr. Kuichling further says that the diagram showing the operation of the lagoons indicates that each lagoon is used only once or twice a year.

The actual sludge area in use in July, 1911, was given to the writer by the works manager as 45,000 sq.m., corresponding to 11 acres, or about 2 sq.ft. per inhabitant, which is six times as much area as is required for drying the sludge removed from Imhoff tanks. It is probable, however, that a part of the 11 acres was used as a place of deposit for the dry sludge. The actual time required for the Elberfeld sludge to reach a spadeable consistency was said to be 7 to 10 months, after which the sludge is deposited on the land where it must lie for at least another month or so before it is fairly dry, and it is still necessary to spade over this fairly dry sludge every year or so into furrows and ridges so as to enable the air to get at it. Four-year old sludge which was being uncovered during the visit of the writer was still moist and the decomposition of the organic matter incomplete. This sludge was also compact and sticky, containing fats and other organic matters, and had an objectionable odor. The sludge removed from the Imhoff tanks at the works of the Emscher Genossenschaft contains on an average of approximately 75% of water. It dries in about a week to a spadeable consistency, without any objectionable odor even during warm, muggy

weather, and the area of sludge drying beds required is only ⅓ sq.ft. per inhabitant. The dried sludge, if wasted, is piled on dumps which can be 10 ft. or more deep, and occupy comparatively little space.

### Character and Value of Sludge

It is stated in the paper that "some of the moist sludge is taken away by farmers for use as fertilizer and the remainder is applied with great success to the large tract of land owned by the city in the neighborhood of the plant." At the time of the visit of the writer, it was stated by the works manager that a small part of the screenings was removed by farmers, but that they would not take the sludge. Most of the experience obtained in Germany tends to show that fresh sludge, although it contains theoretically more valuable organic matter than digested sludge, is, nevertheless, not as suitable as digested sludge for agricultural purposes. The farmers seem to prefer the well digested sludge, because it is porous, and mixes readily with the soil.

### Odor

On July 22, 1911, which was a warm, muggy day, the writer noticed a decided objectionable odor in the vicinity of the building at Elberfeld which contains the screens and grit chambers, and just outside of which the settling tanks are located. This odor was very marked between the buildings and the place of deposit of the screenings and grit-chamber cleanings. In the vicinity of the sludge lagoons and drying areas, it was so strong as to be almost unbearable. Fortunately, the works and sludge drying areas are located in an entirely uninhabited district, a number of miles below the city.

In the opinion of the writer, it would be practically impossible to place a plant of this type at locations, in the immediate vicinity of thickly built up neighborhoods, such as those occupied by practically all of the works of the Emscher Genossenschaft.

### Cost of Operation

Mr. Kuichling seems to be of the same opinion as that held by Mr. Schönfelder, "That the mode of treating the sludge in the cheaply built lagoons at Elberfeld, is much less expensive than the mode of treatment in the costly Emscher tanks," and that the sludge when removed from the Emscher tanks is practically no better than the sludge which has been drying in the open lagoons at Elberfeld for a time equal to the storage in the Emscher or Imhoff tanks.

In considering these opinions, it should not be forgotten that the decomposition in the Imhoff tanks takes place in a very small space under water and out of sight, and without the production of objectionable odors. Nor does it require nearly so much handling as at the Elberfeld works, where the sludge is spread out over large areas, smells abominably in warm weather when drying, and furthermore requires turning over at intervals so that fresh surfaces will be exposed to the action of the air.

At the time of the writer's visit to the Elberfeld works, he was informed that 32 men were continuously employed on the sludge fields, and 8 men to operate the screens, grit chambers, and settling tanks. This total of 40 men corresponds to one for every 6000 people connected with the sewerage system. At the large works of the Emscher Genossenschaft, which give better results than at Elberfeld, the labor required for operating the grit chambers, screens and Imhoff tanks is, on an average, one man for every 35,000 inhabitants, or less than one-fifth of that for the works at Elberfeld.

The original cost of the Elberfeld works, exclusive of land, was given to the writer as 600,000 marks, or 2.4 marks per inhabitant. Works of the Imhoff type, to accomplish the same purpose, have been built in the Emscher district for an average cost of 2.5 marks per inhabitant.

The writer has attempted to present the foregoing information in an impartial manner. He felt, however, that the impression, as to the results of the operation of the Elberfeld works, obtained from reading Mr. Kuichling's article, was likely to be somewhat misleading. It might be said that other engineers, both abroad and from this country, who have visited the Elberfeld works, have found the conditions to be much the same as noted by himself and Mr. Gould, at the time of their visit in July, 1911.

Charles Saville,
Of Rudolph Hering and
John H. Gregory.

170 Broadway,
New York City, Dec. 30, 1911.

[Mr. Saville's letter having been submitted to Mr. Kuichling, the latter sent the reply, which follows.—Ed.]

Sir—I beg to acknowledge receipt of proof of Mr. Saville's letter on the account of the construction and operation of the sewage disposal works of Elberfeld, Germany, which I translated from a paper by the City Engineer, Mr. Schönfelder, and which was printed in your issue of Dec. 28, 1911.

A few words of explanation for making the translation mentioned may be permitted. The Imhoff tank is a novelty in some respects, and the theory of its operation in decomposing sewage sludge is not yet well understood. Various statements had appeared in print concerning the good qualities of the decomposed sludge, but a detailed authoritative account of the mode of working such plants, with results actually attained, was first published last year. As Elberfeld is only a few miles distant from the Emscher district, and as it could fairly be assumed that a reputable engineer and official like Mr. Schönfelder would speak from careful personal knowledge at a national convention of municipal engineers, I regarded this paper as worthy of notice, and accordingly submitted my translation thereof in the hope that it would elicit replies giving further details from those who were fully acquainted with the Emscher plants.

Mr. Saville's comments are very welcome, as they indicate that the plant designed and built by Mr. Schönfelder at Elberfeld does not operate as well as was expected. Whether this is due to peculiarities in the composition of the sewage or to management is not made clear.

The question is whether a very deep tank is necessary to secure a thorough decomposition of the sludge; also, how much tank capacity is requisite therefor in proportion to the volume of sewage and its suspended matter. Many relatively shallow septic tanks giving entirely satisfactory results have long been in use, and a number of Imhoff tanks having a depth of only 10 or 15 ft. are also said to be in satisfactory operation; hence the depth of the tank does not seem to be a very important factor. If this inference is correct, some additional explanation for the superiority of the Emscher type of tank is desirable.

Another point is whether the sludge that is deposited in one or more shallow tanks cannot be drawn off daily in fresh condition into a single deeper tank of adequate capacity, with the result of undergoing the same inoffensive fermentation and decomposition that are said to be characteristic of an Emscher tank. This process would differ but little in principle from the continuous discharge of solid matter through a slot into the sludge compartment; the only variation would seem to be in the quantity of sewage liquid, with its colloidal matter, that is necessarily entrained in the fresh sludge deposited in the shallow tank. Perhaps it is the decomposition of the dissolved and colloidal matter in the sewage that causes the offensive odors, and if so, it affords a good reason for adopting the Emscher type of tank. In this direction, however, little information seems to be available.

E. Kuichling,
Consulting Civil Engineer.

52 Broadway,
New York City, Jan. 10, 1912.

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**A Sanitary Inspection of the Pennsylvania Railroad System** has recently been made. The inspection included the shop, yards and right-of-way of the system, with a view of determining what is already being done in the line of sanitation, and what improvements, if any, need to be made. The work was undertaken some time ago and has been in charge of various local committees.

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# Engineering News

## The Safety of Travel by Water

While the risk of accident in travel by water is still several times as great as the risk in travel by rail, the accident ratio has been reduced in both cases to a remarkably low figure.

The annual report of Supervising Inspector Uhler, of the Steamboat Inspection Service, under the Department of Commerce and Labor, shows that in the fiscal year ending June 30, 1911, the number of passengers carried on vessels under jurisdiction of the service for each passenger who lost his life was 802,981. Small as this proportion is, it is nearly four times as great as the proportion of casualties resulting from travel by rail. The Interstate Commerce Commission statistics for the fiscal year 1909 show in round numbers 3,500,000 passengers carried for each passenger killed. In the eastern United States, where traffic is dense and a much larger proportion of the passenger journeys are short trips in suburban service, the ratio of fatalities is lower still, nearly 10,000,000 passengers being carried for each passenger killed.

A comparison between the total number of passengers carried by water during the year in vessels under the steamboat-inspection service and the cost of carrying on that service shows that the total expense of the government supervision to secure the safety of passengers was less than one-sixth of a cent per passenger carried.

## A Large Ladder Dredge for the Panama Canal

The first ladder dredge of which we have any record is described in one of the earliest volumes of the *Transactions* of the Institution of Civil Engineers of Great Britain. It was built and used in England in 1782; it was operated by two horses and could raise about 30 tons of soft material per hour. The recently completed Panama Canal dredge "Corozal," which is described elsewhere in this issue, can raise about the same amount of material per minute.

In connection with the progress in dredging machinery it is interesting to note that one of the earliest uses of the steam engine was for operating a ladder dredge. Two steam-operated dredges were in use in the River Thames near London in 1819, according to Rees' Cyclopedia, published in London in that year. They were equipped with iron buckets attached to an endless chain, and the ladder worked on the starboard side of the vessel, discharging into a hopper. The steam engine was of 6 hp. and was "so expeditious that it loaded a small barge in an hour and a half."

It was nearly a half a century afterward before dredges were built with bucket capacities of more than 9 cu.ft. In ladder-dredge building the British ship builders have always led and in the case of the "Corozal" their bids were less than half the only American bid received by the Isthmian Canal Commission. The "Corozal" and the "David Dale," which was built a short time ago for the Northwestern Ry. Co. of Great Britain by Lobnitz & Co., of Scotland, now rank as the largest ladder dredges in the world.

## The Alleged Odors from the Columbus Sewage Purification Works

What appears to have been an exaggerated account of the odors generated at the sewage-purification works of Columbus, Ohio, was published in 1910, and seems to have given some people who have never visited the Columbus works and who are not well informed on sewage-purification practice an erroneous idea, not only of the Columbus works, but of sewage treatment in general.

In the "Third Annual Report of the Division of Sewage Disposal, Department of Public Service, Columbus, Ohio, for the Year 1910," Walter W. Jackson, engineer in charge, makes a pointed reply to the criticism mentioned. Inasmuch as we published the original adverse comment (see our issue of Dec. 1, 1910, p. 600), it seems only fair to those who designed the Columbus works and to the officials who have had charge of its operation to print Mr. Jackson's remarks in self-defence, as follows:

The Purification Works has been criticized, on account of the odors present, in a report by Mr. John E. Hill to the New York Board of Estimate and Apportionment. It is to be regretted that a man so ignorant of the art of sewage disposal should have been selected for this investigation. His statements regarding the extent of the zone of positive nuisance and the intensely nauseating effect of the odors are absolutely false, and his failure to qualify other statements shows a lack of comprehension of the problem which is an injustice to the Columbus works and misleading to other municipalities. It cannot be denied that an odor is present at the Purification Works, sometimes rising from the tanks, but chiefly emanating from the filter sprays, but that Mr. Hill's statements are distorted will be apparent to anyone who visits the plant. While the warm-weather sewage is stale before reaching the plant, it is expected that the changes proposed for the preliminary treatment, together with the

aeration of the influent, will ameliorate this objectionable feature.

Although there is no accepted method of measuring sewage-works odors, either as to the area or zone pervaded or as to intensity at a given point, it may not be amiss to say that Mr. Hill's report on odors at Columbus did not agree at all with the observations of a member of the editorial staff of this journal on a visit to the same plant. That the septic-tank effluent, as sprayed on the percolating filters, gave off an odor to the windward was undeniable, but no such an odor was noticed as Mr. Hill describes. Moreover, if the stale sewage from the long outfall sewer was sprayed into the air without tank or other treatment, it seems likely that an odor might result at times.

## The Effect of Temperature upon Journal Friction

The results of innumerable tests which have been made upon journal friction and lubrication have proved beyond the shadow of a doubt that one of the largest factors determining the frictional resistance of a lubricated journal is the viscosity of the lubricant. It is true that for very heavily loaded journals an oil or grease has to be used which has a large amount of "body" and high viscosity, so that it will not be squeezed out from between the bearing surfaces. Such lubricants, however, invariably show a higher coefficient of friction than lubricants of more liquid character.

An interesting confirmation of the influence of viscosity on journal frictions is furnished by the increase in railway-train resistance which occurs during cold weather. It is common practice in railway service to reduce the tonnage rating of locomotives from 10 to 15 per cent. on account of the increased train resistance in winter over that in summer.

Some recent investigations of the effect of temperature upon the frictional resistance of railway-car journals were described by Prof. Edward T. Schmidt, of the University of Illinois, at the January meeting of the Central Railroad Club. Prof. Schmidt's tests showed that the frictional resistance of car journals was increased as much as 25 per cent. by exposure to winter temperatures. Inasmuch as other elements of train resistance and possible tractive power, such as grade, power required for starting trains, etc., are not affected by temperature, a reduction in tonnage rating of 10 to 15 per cent. is generally sufficient to cover this increase in journal friction during the winter.

A very clear idea of what takes place in a car journal-box is given in the following extract from Prof. Schmidt's paper:

In the journals of a car which has been standing for some time, the oil film has been broken through and the journal and brass are probably in direct contact. The temperature of the oil and of all the bearing parts is the same as that of the air, and the lower this temperature, the more viscous is the oil.

As the car starts and the journal turns, oil is brought up from the waste below and the film of oil begins to establish itself. Until this oil film is established over the whole journal the friction is high and gives rise to the great starting resistances which prevail at this time. Low air temperature not only makes the oil more viscous but lengthens the period during which the film is being established, and it probably not only increases the starting resistance but maintains it for a longer time.

As the journal continues to turn, the oil and all bearing parts begin to warm up, due to the heat developed by the bearing friction. As the temperature increases, the viscosity of the oil diminishes and the resistance decreases. The temperature of the bearing continues to increase until the rate of heat production within the bearing equals the rate at which the heat is dissipated from the box and other parts, such as the axle. At this point, the bearing temperature becomes constant and the resistance reaches its minimum value and here remains.

This dissipation of heat is accomplished by the air moving over the box and axle, and the rate of heat dissipation varies almost directly with the amount of the difference between the temprature of the bearing and the temperature of the surrounding air. To maintain a certain rate of dissipation of heat, the journal temperature may be lower, therefore, in cold weather than in warm weather; the temperature of equilibrium attained by the journal is consequently lower in cold weather than in warm weather, and the minimum viscosity of the oil is greater. On these accounts we are prepared to find that the minimum resistance attained in cold weather is greater than in warm weather.

These statements are exemplified by the following record of journal temperatures obtained by the use of the University of Illinois dynamometer car:*

| | | |
|---|---|---|
| Test number | 1094 | 2007 |
| Average air temperature—degrees F. | 63 | 9 |
| Approximate average test-speed—M. P. H. | 16 | 15 |
| Maximum temperature attained by test car journal—degrees F. | 116 | 98 |

There is every reason to suppose that what applies to car journals is true also for all journals lubricated with oil or grease, and that the friction of all journals varies inversely with the air temperature. So long, therefore, as a journal is not heated to the point at which the lubricant becomes injured and danger of over-heating occurs, it is an advantage to have the journal warm and to reduce the loss of heat from it.

It has even been suggested that railway journal boxes might be protected by nonconducting shields, which could be removed in the spring, so that the winter train load might approximate more nearly to that which can be handled in summer.

## The Need of State Engineer

"It is urgently necessary that ever state of the Union which has not alread done so should establish at an early dat an office of State Engineer or its equiva lent."

The above quoted statement was mad by Gen. Wm. H. Bixby, Chief of th Corps of Engineers, U. S. A., in hi address before the National River and Harbor Congress, which we printed in our issue of Jan. 11. We need say noth ing to the readers of ENGINEERING NEWS regarding General Bixby's eminence as an engineer. He is an engineer, moreover, who is fitted by ability and experience to take a broad view of important public questions. His opinion as to the need of State Engineers ought to carry great weight with every state legislature in the United States.

In his address Gen. Bixby referred to the work which State Engineers should do, in connection with state control of drainage, irrigation, water power and other public utilities relating to the use of water. This, however, is only a part of the work which a properly organized State Engineer's office ought to take in charge. The recent Austin Dam failure emphasized the need of state supervision of dam construction. The current good roads agitation is making evident the extent to which money now spent on highway work is wasted, and the need of competent engineering supervision to secure efficiency in road construction and maintenance. State supervision of works undertaken for municipal water supply and for sewage disposal is still an urgent need in most of the states. There is also need almost everywhere of some authority to inspect the construction and operation of public buildings, factories, etc., located outside of cities where municipal supervision is in force. In Massachusetts, a department known as the District Police has in charge the inspection of boilers, buildings, factories, etc., which were it not for this supervision might be so built and maintained as to cause great danger to the public.

The situation, summed up in a nutshell is that a vast amount of engineering work which ought to be done is now left undone in nearly all the states to the great detriment of the public.

Probably no argument is needed to convince any member of the engineering profession of the truth of Gen. Bixby's statement that every state in the Union should have a competent state engineer. The question is how the establishment of such offices is to be brought about? How are state legislatures to be made aware that their state needs a State Engineering Department? How shall they learn the wisdom of fixing salaries at a rate sufficient to attract thoroughly competent men, of providing a sufficient force to cope with the amount

of work that needs to be done, of making the tenure of office so permanent and so free from political control that real efficiency can be developed? All these things seem self evident to an engineer, but what does the general public and the state officials and legislatures which represent the public know about these matters? How shall they know, if engineers who have the necessary knowledge do not take pains to inform them?

It is perhaps true that engineers as individuals can do comparatively little, although it occasionally happens that some member of the profession of high standing and influence is able to make suggestions and give advice which may have important results in shaping legislation. Engineers associated together, however, if they make use of the influence they may rightfully claim, ought to be able to accomplish a great deal in securing legislation for the public benefit.

We have spoken frequently of the influence the engineering societies ought to exert in public matters. In the present case, it is manifest that the responsibility lies on the local engineering societies rather than on the national societies. Why should not resolutions be adopted by every state engineering society at its annual meeting this Winter, in all states where an efficient state engineer's office is not now established, urging the Legislature to create the office of state engineer, setting forth the reasons why, in the public interest, a state engineering department should be organized, laying down the principles on which appointments to the office should be made and defining the work which such an office should carry on. If the engineering profession desires to fill the large place in public life, which ought to be its own, no opportunity should be lost to make its voice heard in such matters as the one now presented.

## Annual Meeting of the American Society of Civil Engineers

The fifty-ninth annual meeting of the American Society of Civil Engineers, held at the society's house in New York City on Jan. 17 and 18, 1912, brought together the usual large number of members. In addition to the regular business meeting on the morning of the 17th, there were excursions to the new shafts which are being sunk for the proposed tunnel aqueduct under the City of New York, to the new Grand Central Terminal improvement, to the subway works at Fourth Ave. in Brooklyn, and to the Mt. Pleasant Laboratory of the Department of Water Supply, Gas & Electricity of the city, all on the afternoon of Jan. 17, and an all-day excursion to the Bush Terminal improvement in South Brooklyn, on Jan. 18. The social features of the meeting included the president's reception at the house of the society on the evening of Jan. 17, and a smoker at the house on the evening of Jan. 18. Following the regular annual meeting, there were held on Jan. 19 and 20 three meetings of the society at which the subject for discussion was "Road Construction and Maintenance." An account of these meetings will be found below.

OFFICERS—Out of the 1866 votes cast for president of the society, John A. Ockerson (St. Louis, Mo.), the nominee of the Nominating Committee, received 1458, and Richard Montfort (Louisville, Ky), who was nominated by petition, received 408. Mr. Ockerson was therefore declared president for the ensuing year. The other officers elected were as follows:

Vice-Presidents: Charles S. Churchill (Roanoke, Va.) and Charles O. Marx (Stanford University, Calif.).

New Members of the Board of Direction (term expires January, 1915): Lincoln Bush (New York), T. Kennard Thomson (New York), Emil Gerber (Pittsburg, Penn.), William Cain (Chapel Hill, N. C.), Eugene C. Lewis (Nashville, Tenn.), William A. Cattell (San Francisco, Calif.).

Members of the Nominating Committee: Merritt H. Smith (New York), Harrison P. Eddy (Boston, Mass.), Alexander E. Kastl (Albany, N. Y.), John F. Murray (Philadelphia, Penn.), Archibald S. Baldwin (Chicago, Ill.), John F. Coleman (New Orleans, La.), Richard H. Thompson (Seattle, Wash.).

### BUSINESS SESSION

The business session was devoted entirely to the reports of the officers, the announcements of the election and the reports of the standing committees.

During the past year the society has had the largest increase in numbers in its history. The membership at the end of 1911 was 6326 in all classes, a net increase of 529 during the year. Of the 712 applications for admission to membership, 652 were acted upon favorably. The treasurer reported that during the year $10,000 was paid on the principal of the mortgage on the society property, reducing this debt to $125,000. An addition of $20,000 was made to the reserve fund, established last year. The Board of Directors has ordered that $10,000 be paid on the principal of the mortgage early in the present year, and that $20,000 be added to the reserve fund. The general balance sheet accompanying the report of the secretary showed the society to be in a very prosperous condition. Its income for the year was about $141,000, and its expenses about $103,000.

PRIZES—The secretary announced the following award of prizes for papers contributed to the Proceedings of the Society during the year ending June 30, 1911:

The Norman medal to George Gibbs for a paper entitled "The New York Tunnel Extension of the Pennsylvania R.R.; Station Construction, Road, Track, Yard Equipment, Electric Traction and Locomotives"; the Thomas Fitch Rowland prize to Messrs. B. H. M. Hewett and W. L. Brown for their paper entitled "The North River Tunnels," and the Collingwood prize for Juniors to A. Kempke for his paper entitled "A Concrete Water Tower."

A resolution was offered and adopted authorizing the Board of Directors to pay for the collation which is served at the regular semi-monthly meeting of the society at its house in New York. Hitherto, this collation has been paid for by voluntary contributions from the local members.

A motion was made by a member that the society appoint a committee of eight members to look into the conditions of employment in the engineering profession, particularly in regard to the matter of wages of salaried engineers, with a view toward their betterment. A motion to lay on the table was defeated and the motion was then referred to the Board of Directors for action.

### COMMITTEE REPORTS

CONCRETE AND REINFORCED CONCRETE—The Committee on Concrete and Reinforced Concrete, which forms a portion of the well known Joint Committee on the same subject which presented a report three years ago, reported that it had met five times during the past year and had made a number of modifications in its original report, which modifications had been submitted to the various other societies comprising the Joint Committee, and had promised up to a few weeks ago to be ready in time for this annual meeting. However, it was not now ready to be presented. The committee, therefore, presented a progress report and stated that it hoped to be able to bring out its final report soon.

ENGINEERING EDUCATION—This committee, through Desmond FitzGerald, its chairman, reported that it had investigated the subject of engineering education further during the year and had prepared a set of diagrams showing the number of hours' work given to various subjects in a number of the different technical schools in the country. It further reported that there was good reason to believe that the Carnegie Foundation during the ensuing year would take up the subject of engineering education in the same manner that it has already taken up the subject of medical education.

UNIFORM TESTS FOR CEMENT—The Committee on Uniform Tests for Cement reported that during the past year it had

conferred with the members of the United States Government Departmental Committee and with members of the similar committee of the American Society for Testing Materials in regard to developing a uniform specification for cement. These various committees came to an agreement on a uniform test in all respects except in regard to the test for preliminary set and for consistency. For this particular test the Departmental Committee, and particularly the delegates from the Board of Engineering, U. S. Army, would not accept the Vicat needle test which is now incorporated in the American Society of Civil Engineers' tests and which the committee from that society insisted upon retaining. The committee report before the present meeting of the society consisted mainly in the defense of the Vicat needle test. The various committees were not able to come to an agreement upon the subject, so that at present, at least, a uniform specification for cement testing has not been achieved. In addition to the Vicat needle discussion, minor changes were made in the American Society of Civil Engineers' specifications and some paragraphs on minor issues in the testing were added.

COMMITTEE ON STEEL COLUMNS AND STRUTS—According to a progress report, the committee has during the past year continued its studies of column tests with particular attention to the relation between ultimate failure and the yield-point of the metal. The notable series of tests of five columns of 90 sq.in. cross-sectional area by the Pennsylvania Lines West of Pittsburg, reported by J. E. Howard in a paper read before the society during the past year, was also studied carefully. Following upon the extensive investigation program begun at Watertown Arsenal some years ago, the committee plans to continue similar work under the auspices of the Bureau of Standards. A test program has been outlined, and the tests are shortly to be begun there. These tests, it is understood, will cover a variety of shapes of column sections and will be made on specimen columns in such sizes as can be handled by the testing machine.

The American Railway Engineering Association has also begun consideration of steel columns through its committee on steel structures. This committee will act in harmony with the Committee on Steel Columns and Struts in order to avoid duplication of work.

BITUMINOUS MATERIALS FOR ROAD CONSTRUCTION—This committee presented a report outlining the main features to be considered in a study of the use of bituminous materials for road construction. These notes were not offered as a complete exposition of the subject, but merely as a temporary statement of the present state of the art. The headings included the subject of traffic census, crowns, subgrades and foundations, nature of bituminous materials, methods of construction, construction details, cost data and nomenclature.

## A Conference on Road Construction and Maintenance

Following the annual meeting of the American Society of Civil Engineers, four meetings were held at the society's house in New York City, on Jan. 19 and 20, for topical discussions on the construction and maintenance of roads and pavements. There were four general topics under which the speakers were to attack the subject, but the presiding officers allowed the greatest liberty, both as to subject and time, so that two days was scarcely enough to give all a hearing. The attendance was about 200.

Throughout the several sessions, a very general agreement of opinion was evident regarding four important questions. (1) There was a tendency to explain road-surface failures as the result of poor foundations or lack of drainage. (2) The joints of brick and stone-block pavements were being filled more and more with a portland-cement grout; but most engineers still hold that there are situations where noise and expansion troubles can be avoided only by the use of a soft filler like sand, or gravel and tar (or asphalt). (3) Increasing success was shown in proper maintenance of plain macadam roads, on which automobile traffic predominated, by bituminous surface treatment to build up a traffic mat. (4) There was manifest a general belief in the greater life of a bituminous-bound broken-stone road in which the stone and bituminous binder had been mixed before laying, compared with a road where the bituminous binder was poured.

DRAINAGE AND FOUNDATIONS — James Owen, of Newark, N. J., opened this discussion with a paper in which he reviewed "crystallized and accepted" practice. He held that drainage and foundations were to be arranged in any given case in accordance with climate, soil, traffic and the pavement itself. He excluded from consideration the less than 10% of this country which had so little rainfall that drainage could be neglected. The problem had two aspects, (1) removal of surface water and (2) prevention of underground flow. Macadam was not to be regarded as waterproof, so that a minimum crown (about ¼ in. to 1 ft. width) and fall (0.5 ft. on 100 ft. in the sub-grade) was necessary, though the use of bitumen-bound road material gave a waterproof roadway which could be built with less fall and crown than ordinarily needed. Mr. Owen believed in the use of foundations always and in the use of a good frost-proof stone therein.

Logan W. Page, director of the U. S. Office of Public Roads, Washington, D. C., said that there existed a belt across the country for which it was possible to fix some general tenets in roadbuilding on account of a favorable topographical situation with plenty of good materials accessible. But for the Southern and Southwestern states there were no precedents for construction in the gumbo soils, with the rivers higher than the roads and with very little money available.

F. C. Pillsbury, division engineer of the Massachusetts Highway Commission, Boston, Mass., cited cases where gravel, cinders and slag had been used as a base, giving ample drainage in cases where the traffic did not demand a Telford base.

J. A. Johnson, division engineer of the Massachusetts Highway Commission, Boston, Mass., noted that the elaborate provisions for drainage and foundations which the commission started out with, had been materially simplified. For such country roads as needed a heavy foundation, it was usually sufficient to lay field stone on a smooth sub-grade, without hand-setting and wedging; more than 4 in. of broken stone on this was unnecessary. In each case, for success, engineering judgment and skill were needed.

Clifford Richardson, of New York City, urged a closer study of the topography of the countryside in providing drainage. He believed that a road, as much as a house, needed "a dry cellar and a tight roof;" if ground water was found within 3 ft. (depth) of the foundations it would find its way up into the road unless guarded against.

Maj. W. W. Crosby, of Baltimore, Md., described the use of sand, screenings, cinders and run-of-crusher stone worked into a poor subsoil before making a macadam road.

H. P. Willis, division engineer, New York State Highway Department, Albany, N. Y., held that a more scientific attack of the problem needed to be made than any discussion had yet shown. He believed that first of all the subsoil must be treated so as to be able to bear the road; for that, moisture must be kept off from above and also kept from working up from the side ditches. He recommended (1) lining side ditches with puddled clay and (2) a vertical ditch, along the edge of the stone, filled with vertical plates of tile or asphalted clay.

E. N. Hines, of the Highway Commission of Wayne County, Mich., described the activities of that commission. They first tried bituminous macadam, but gave that up for rich portland-cement concrete in all cases. They had 33 miles (about 6000 monolithic sections, with expansion joints) of various experimental constructions and on all of this only $200 had been spent for repairs; some was three years old and some only a month. Cracks had been found on about 100 of the 6000 sections. They had secured $2,000,000 to be spent in the next five years for this type; they proposed to build such roads in 20-ft. sections, 7½

in. thick and 16 ft. wide, with protected expansion joints and 4-ft. gravel shoulders; the mix would be 1:2½:3. The crown would be ¼ in. to 1 ft., and the top would receive a thin bituminous coating.

FILLERS FOR BRICK AND BLOCK PAVEMENTS—This topic was first presented by G. W. Tillson, consulting engineer of public works, Borough of Brooklyn, New York City, who reviewed the use of sand, tar and gravel, pitch, and portland-cement grout for sealing the joints to hold the blocks in place, to prevent wear at the edges, and to keep water off the foundation. He pointed to some recent paving on Fourth Ave., New York City, with close-set granite blocks and pitch and gravel joints, as a notable example of what could be done under proper specifications. The very elaborate specifications for grout-filled stone-block pavements in Newark, N. J., were quoted.

Mr. Tillson had found that sand was good for a temporary filler only (except for wood blocks, which could be set close and which broom out under traffic enough to seal the joints). Tar and gravel had proved better in theory than practice, as blocks so set soon became "turtle-backed." He believed that by giving proper care to foundation, bed and expansion joints cement-grout filler could be used without making a brick or stone pavement extra noisy or apt to crack. However, it might be found too smooth for grades and too difficult and expensive of repair alongside street-railway tracks. Under such conditions the best bitumen filler should be used and it should be very carefully placed.

W. P. Blair, secretary of the National Paving Brick Manufacturers' Association, made an extended argument for the use of cement-grout filler in stone and brick pavements, first, last and always. His extreme views were not held by many, especially those from the South and Southwest where, it was claimed, the long, hot summer and need for frequent access to pipes made a soft binder imperative.

L. T. Sibley, assistant Eastern manager, Barrett Manufacturing Co., New York City, in discussing fillers for wood block, stated that it had been found that no sand cushion was necessary. The blocks could be laid on a smooth concrete foundation, which had been mopped over with pitch; one end and a side were dipped in pitch, the dipped end being laid down and the dipped side in contact with an undipped side of blocks already laid. This also prevented upheaval by sealing the lower end of the blocks so that water could not rise in them by capillary action.

BITUMINOUS SURFACES—A. W. Dean, chief engineer, Massachusetts Highway Commission, Boston, Mass., opened the discussion of this topic by defining it as relating only to superficial applications on roads in place, for the purposes of laying dust and preserving the surface. He held that, while much had been learned so that very considerable success could be obtained, yet the work was still in an experimental stage. There was no universal specification yet for all roads and all kinds of traffic. He had found tars good for macadam, but of little value on gravel roads, where better results had been secured by using an asphaltic oil of medium viscosity (at ordinary temperatures). Where the travel over a stone road was mostly of light motor vehicles (compared with motor trucks) applications of hot, heavy asphaltic oils had been found best. While natural asphalts were preferable, yet petroleum-residue oils could be used with much success. It was essential that the dust should be thoroughly cleaned off the road and out of the stone; the oil might well be applied under pressure in amounts to give about ¼ gal. per sq.yd. and should be followed by grits. The character of the latter is important — sand being preferable for motor-vehicle traffic and pea-stone for any great amount of horse-drawn traffic. However, where the horse-drawn traffic is a large proportion of the whole, such methods will not give a mat that withstands the hoofs and steel tires; heavy tar, or light oils frequently applied, may then be tried.

Frederick E. Ellis, of Melrose, Mass., held that the source of most trouble with surface applications was in making the material adhere to the road; he favored a top course of 4 in. of 1¼- to 2½-in. stone, since that, once compacted, can be cleaned better than the small stone. The stone, to be scattered on after the bituminous material, he would have of a diameter equal to the desired thickness of mat, so that the load would be more borne by the stone than binder.

W. H. Connell, assistant commissioner of Public Works, Bronx Borough, New York City, described the abandonment of water sprinkling in that borough. The roads were given a bituminous treatment depending on their character and traffic. The ordinary macadam streets were given ⅓ to ½ gal. of tar preparation per square yard, with a coat of torepdo sand or washed gravel, at a cost of 3.5 to 4.5c. On one important boulevard, 0.6 gal. of heavy tar was used at a cost of 13.8c. per sq.yd., though normal cost would be 9 to 10c. Medium asphaltic oils were used in ¼-gal. doses once a year at a cost of 1.3c.; in some cases traffic demanded two applications per year. Heavy asphaltic oils had been used at a cost of 2.8c. These figures were to be compared with 5.8c. per sq.yd. per year for water sprinkling—three or four times a day for 180 days in the year. In future work, pressure-type of oil distributors were to be used, cutting down the labor from one to three men.

Clifford Richardson explained the strange effect of getting better penetration of bituminous materials when stone is slightly moist than when it is dry, by the action of the water in turning adherent dust into a paste which emulsifies with the bituminous material and allows this to come into direct contact with the stone. He stated that asphalt and water would emulsify in the presence of colloidal matter like clay, and that the emulsion could be diluted to aid in application.

Harold Parker, vice-president of the Hassam Pavement Co., Worcester, Mass., described the use of a tar preparation on top of a concrete road built some seven years ago in Massachusetts. The surface coat wore until two years ago, when a new coat was applied and the road was as good as ever.

E. W. Grove, of Ann Arbor, Mich., described pavement laid there of asphalt blocks covered with hot coal tar and sand. They had a concrete pavement with a ¾- to 1-in. expansion joint every 25 ft., and a ¾-in. traffic mat of hot tar and sand. This has been put down by the city at $1 per sq.yd.

Prof. A. H. Blanchard, of New York City, in discussing distributing machines, stated that he had found none that satisfactorily distributed all materials in all amounts in spite of all-inclusive claims. The engineer had to use a machine which could be demonstrated to answer his requirements under his road conditions. He had found 0.4 gal. per sq.yd. to be the minimum that any present gravity machine would deposit, while the minimum of a pressure type was ⅛ gal. None of the available machines had been calibrated so that the amount of material laid could be fixed from the temperature, material, speed and valve openings. He believed that in 75% of the surface applications of 1911 it would have been advisable to use material that set up in 24 hours; he expected that the demand for such would soon be insistent and must be met.

BITUMINOUS MATERIALS IN PENETRATION AND MIXING METHODS—In opening the discussions of the final topic, Linn White, of Chicago, described the progress of work in South Park district, where theree were 60 miles of drives, carrying from a few hundred to 17,000 vehicles per 24 hours, 400 of these being heavily loaded. About 90% of these drives were of macadam—plain or bituminous. The work started in 1905 with asphaltic emulsions and light oils, but success was first secured with tar compounds and screenings. They had progressed to pouring tars and heavy asphaltic oils during construction, but the roads rutted and waved. In 1908, they had gone to mixing methods and had found them only slightly more expensive and far better. They were using last a thin waterproof wearing surface on a larger stone undercourse; a 2-in. layer cost 52c. and a 1-in. one 32c.

A. F. Armstrong, formerly chief of the Research Bureau of the New York State Highway Department, reviewed very generally the New York State work. He said that the bituminous macadam roads laid by the penetration method in 1909-10-11 were still in good shape, with only about 1% of failures and these due to late-season pouring, poor labor, wet stone and poor foundations. He held that the road must receive at least one month of warm-weather traffic to become properly consolidated.

Clifford Richardson called attention to the better results in bituminous-bound pavements with hard limestone over trap rock and explained the difference by the glassy surface of a fracture of the latter which resulted in poor adhesion.

Prof. A. H. Blanchard described the present condition of several sections of the Nayatt Point experimental road near Barrington, R. I. (built in 1909). The traffic was light—300 high-speed motor vehicles and 100 horse-drawn per day. A section made with water-gas tar (mixing method) showed a mosaic surface, but would need no repairs until 1913, and then a new bituminous top. Sections laid with refined coal tar and with mixed tar and asphalt (mixing methods) would need attention in 1912. A section where an oil company's asphalt binder was used (also laid by a mixing method) showed an asphalt surface, and would need nothing for two or three years. None of these surfaces were now slippery, though the tarred ones had been last year. He believed that inexpensive mixers were now available for mixing one size run-of-crusher stone and binder at a cost (for mixing only) of 3 to 6c., which brought the work done to the level of penetration. This pavement he believed the most "fool proof" developed. Where graded stone and sand were to be mixed with asphalt he recommended more expensive apparatus. Less fear of infringement suits over graded aggregates was to be feared as decrees, etc., had now been secured defining mixtures which were admitted to be beyond the scope of patents granted.

P. P. Sharples, of the Barrett Manufacturing Co., New York City, maintained that local conditions must govern the selection of penetration or mixing method and that comparisons between town and country roads were not very useful on account of very different load and traffic conditions. Roads made by penetration methods needed, perhaps, more careful attention than those laid by mixing methods, to prevent extension of incipient raveling. He advocated a flush, or seal, coat of bitumen in all cases and care to never let a surface get broken up.

W. H. Connell described the present condition of the 18 experimental strips on the White Plains road in Bronx Borough, New York City. (These were described, when completed, in our issue of Jan. 19, 1911, p. 66.) There was some trouble with poor foundations, but a few sections were too soft at high temperatures and some proved too hard. We expect to give in a future issue some of Mr. Connell's figures for repairs, etc., during the year.

Albert Sommer, chemist, the Barber Asphalt Paving Co., Philadelphia, Penn., briefly described a new and promising method of testing the composition and value of various bitumens. It appears that it has recently been discovered at the Imperial Testing Station, in Berlin, Germany, that acetone converts such hydrocarbons into oils and pitches, while its homologue "butanon" also splits up the hydrocarbons and, being able to absorb 110 times its volume of water, the oil content can be separated from the pitches. In comparing various bitumens, the amount of pitches obtained corresponded to known utility, and the quick-setting ones yielded unsaturated constituents which oxidized and hardened.

## Sewage Treatment by Slate Beds at Devizes, England*

By F. G. Billingham†

The mode of sewage disposal in Devizes is the process known as "Dibdin's slate beds," which has now been in work between six and seven years, and has given every satisfaction.

Previous to the entire plant being laid down, we had an experimental slate bed, followed by a coke-breeze secondary bed. This was worked for twelve months, and carefully watched, with the result that the council had no hesitation in adopting the system.

Previous to this, the system in use was that of precipitation by aluminoferric, the sludge obtained being mixed with lime and pressed. This was not only very costly to work, but resulted in such an enormous accumulation of pressed sludge that we were unable to get rid of it. I estimate that we made about 700 [long] tons per annum, and the annual expenditure was from £650 to £700 [say $5 per long ton] for labor, chemicals, coal, etc. The nuisance was considerable, and we were constantly getting complaints from the town as to the smell when the wind was in the west or south-west.

The present plant consists of six slate beds, 68 ft. by 45 ft., and two storm-water beds, 80 ft. by 68 ft., and ten coke-breeze beds, 68 ft. by 45 ft., as well as two grit chambers, being two of the old precipitation beds, which, however, do not come into use except during wet weather. Upon all other occasions the sewage from the town runs directly on to the slate beds, without any screening.

The sewage is a very dense domestic sewage, with washings from large slaughter-houses, dairies and breweries; the dry-weather flow is 240,000 U. S. gal. per 24 hours. We have no separate system, all the storm water being taken into the sewers.

After dealing with a six-volume flow [six times the dry-weather flow or 1,440,000 U. S. gal. per day], the storm water, etc., is distributed over land.

The slate beds are filled consecutively, and take about two and a-half hours to fill; they are allowed to rest about three hours, and then emptied slowly, the effluent being treated on the secondary fine coke-breeze beds in a similar manner.

At the commencement of emptying a slate bed, and during the last draining, most of the humus comes away, and is diverted on to a small, dry ash bed to drain and dry.

The total cost of working, irrespective of new works, repairs, etc., is under £200 [$975] per annum, beside which we have no large accumulation of sludge. The humus when dry is easily dealt with, and forms no nuisance. The quantity made has never been measured, but I estimate it, after air drying, at about 20 to 30 [long] tons per annum. The grit from the storm-water chambers is allowed to run on to a large withy bed; this, of course, contains a very small proportion of sewage matter.

The final effluent from the secondary beds is so good that it can be, and is at times, run into the brook direct, as well as over land. In fact, when it is not wanted on the land it is run directly into the brook, and we have not received any complaints.

I am of opinion that this system solves the sludge problem, gives an excellent effluent, and a total absence from smell from beds; and that the slate beds do not silt up, as they did not lose capacity after the first twelve months.

[The Dibdin slate beds, devised by W. J. Dibdin, a prominent chemist of London, consist of slabs of waste slate, supported by small blocks so as to form considerable horizontal interstitial space. They are virtual contact beds, with coke or other lumpy material replaced by slate.—Ed.]

*From the London Surveyor of Dec. 22, 1911.

†Borough Surveyor, Devizes, England.

**Telephone Lines** for the construction of the Los Angeles Aqueduct, total 440 miles in length, of which 240 miles are main lines and 220 are local lines. The main telephone lines extend from the Aqueduct intake, in Owen Valley, to the Los Angeles city limits, where connection is made with the Home Telephone Co.'s system. There is, however, a direct wire connection from the intake to the general offices of the Los Angeles Aqueduct. William Mulholland is chief engineer and J. B. Lippincott is assistant chief engineer of the Los Angeles Aqueduct.

# Annual Convention of the Illinois Society of Engineers and Surveyors

The 27th annual meeting was held at the University of Illinois (Urbana, Ill.), Jan. 17 to 19, and the interest of the proceedings was added to by the opportunity of hearing and seeing what the university is doing in various fields of engineering education. Practically the whole of one afternoon was devoted to this particular subject, brief addresses being made by the heads of different departments in the College of Engineering, after which the members were taken for an interesting tour through the various departments, the laboratories, and the Engineering Experiment Station. An informal social meeting, also, was held at the office of Dr. W. F. M. Goss, dean of the College of Engineering, which gave an opportunity for the members to meet the faculty. The papers were presented largely in groups dealing with particular subjects, thus adding to the interest and tending to promote discussion.

### Water Supply and Sewerage

We group these subjects together as they are so closely related, the papers in each group dealing largely with the problem of water pollution. The report of the Committee on Water Supply reviewed the purpose and work of about eight organizations which have to do with the oversight of water resources and supplies in Illinois. Prominent among these are the following: (1) The Illinois State Water Survey, which in 1911 received an appropriation of $20,000 per year for its investigation work (particularly as to pollution of streams); (2) the Rivers and Lakes Commission, created by the legislature in 1911 to take over the work of the Internal Improvement Commission; it is composed of three members, one a civil engineer, one a lawyer, and one who is neither a lawyer nor an engineer, but who is intimately acquainted with the rivers and lakes of the State; (3) the Lake Michigan Water Commission, and (4) the Sanitary District of Chicago. Two others, of wider scope are the Great Lakes International Pure Water Association and the National Association for the Prevention of Pollution of Streams and Waterways. A paper on "Stream Pollution" was presented by Paul Hansen, engineer for the State Water Survey.

The report of the Committee on Sewers outlined the attempts made to control the sewage disposal and water pollution in a large district to the north of Chicago. It showed also that recommendation has been made to rebuild the sewers of the business district of Chicago, adopting the separate system, while the immediate installation of sludge-collecting tanks at some sewer outlets has also been advocated. Reference was made to the Emscher tank as being superior to the septic tank in providing for settlement and collection of sludge without permitting the septic action to come in contact with (and pollute) the outflowing fresh sewage.

A paper on "A Local Sewage Disposal Problem," by F. L. Stone (Chicago), outlined the experience of an Illinois town of 3500 people with a septic tank built some years ago.

In a paper on "Sewage Disposal," by Langdon Pearse (Asst. Eng., Chicago Sanitary District), stress was laid upon the necessity of testing the working efficiency of the various disposal plants throughout the state. In many cases they are held as examples to prove or disprove the value of treatment, when as a matter of fact nobody knows how they are operated or what are the actual results. Bad results may be due to improper working or lack of proper attention, rather than to defects in the system. But until actual results are scientifically determined, on a basis allowing of direct comparison, the value of statements regarding these plants is very slight.

A paper of a different character was presented by G. C. Habermeyer (U. of Ill.) on "Formulas for Flow in Sewers," in which a number of different formulas were discussed.

### Land Drainage

The society has always given a large amount of attention to this subject, as it deals with a wide field for engineering work in Illinois. The report of the Committee on Drainage dealt with the general conditions and with the movements now on foot to treat the matter in a broad and general way, rather than in regard to individual cases. A special Committee on Drainage Legislation stated that 40 bills dealing with the drainage laws of the state were introduced in the legislature in 1911. Three of these were passed, dealing with (1) the case of one district draining water into another district, and (2) changes in the law relating to drainage pumping plants. The legislature also appointed a commission to revise the drainage laws, but as no appropriation was made it is probable that the commission will take no action.

There are many cases in Illinois where drainage work involves levees to protect land against flood or overflow waters, and where the drainage water must be handled by pumping. In relation to this subject, a paper on "Mechanical Engineering Problems in the Drainage of River Bottom Lands" was presented by J. J. Harman (Peoria).

### Surveying

This society is one of the few local societies which retain the term "surveyors" in the title, and it has justified its action in this respect by the amount of attention which it gives to the work of the surveyor. This applies both to land or property surveying, and to the surveying done in connection with engineering work.

The greater part of one session was devoted to this general subject, and included a very active discussion on the papers. A paper on "Instruction in Surveying," by A. R. Alger (U. of Ill.), reviewed the methods employed in educating engineering students in this line of work, and G. W. Pickels (U. of Ill.) discussed the relative merits of the traverse, radiation and intersection methods of surveying areas, in a paper on "Relative Accuracy of Various Surveying Methods."

In a short paper on "A Large City Survey," S. N. Howard (Chicago), described the methods of surveying the property acquired by the Chicago & Northwestern Ry. for its new passenger terminal. Prof. W. H. Burger (Northwestern University) presented two papers of interest. The first was on "Direct Solar Observations for Determination of the Meridian," in which he pointed out that this method is rapidly replacing that by the use of the solar attachment. The second paper was on "A New Design for Graduation of a Stadia Rod," the graduation in this case being rectangular (by horizontal and vertical lines only) instead of triangular. It was stated that with the lines of the latter diagonal to the telescope wires it is difficult to estimate small fractions of a foot at short distances, and difficult to make observations on account of the blurring caused by heat vibrations.

### Roads, Paving and Bridges

The papers on these subjects overlapped to a large extent, there being no definite distinction between street paving and road construction, while the matter on bridges related mainly to highway bridges of the smaller class on country roads.

In "Brick Paving on Country Roads," W. T. Blackburn (Paris, Ill.) dealt with work described some months ago in Engineering News, and this was supplemented by views and remarks presented by W. P. Blair (Cleveland, O.). The report of the Committee on Roads and Pavements referred to the work of the State Highway Commission, and to the vexed question of special assessments for improvement work. Wood-block paving for streets was referred to in two papers, but particularly in regard to the joint filler used. In "Experience with Cement Grout Filler," A. J. Schafmayer described recent work in Chicago which is taken to show that this material is less satisfactory than a bituminous filler, while in a paper on "The Use and Abuse of Coal-Tar Paving-Pitch Filler," the advantages of this latter material were reviewed by E. W. Johnson.

As to bridges, B. H. Piepmeier (of the State Highway Commission) described a

set of diagrams prepared by the engineers to enable estimates of quantities and cost to be made very rapidly for bridges of reinforced concrete, including both the through girder type and the slab type. In close relation to this was a paper on "Proportioning Gravel Concrete," by C. Older (of the State Highway Commission), who discussed the matter particularly with regard to concrete highway bridges, as gravel is in general more easily obtained than broken stone. As illustrating the abuse of concrete by inexperienced men he cited a case where the contractor for a small bridge claimed that a 1:6 mixture meant one sack of cement to six wheelbarrows of gravel. The paper was accompanied by specifications for concrete and by diagrams for use in the proportioning of concrete mixtures.

Defective methods in the design and erection of small steel highway bridges were described by N. B. Garver (U. of Ill.) The Committee on Records of Bridges has advocated compulsory filing (with public authorities) of plans for bridges on public highways, so that there may be permanent record of these structures, but it reported that bills for this purpose have been defeated in the legislature. A paper relating to a rather different class of structure was one on "The Design and Construction of Tall Viaducts," by L. J. Towne (U. of Ill.).

### Other Subjects

A paper of interest in regard to concrete construction was on "The Mortar-Making Qualities of Illinois Sands," by C. C. Wiley (U. of Ill.). He questioned the utility of specifying "sharp" sand, stating that it was the condition of surface roughness and not shape of the grains which affect the adherence of cement to the sand. Prof. F. O. Dufour gave an illustrated talk on "Railway Construction," referring to methods employed in modern work for heavy excavation, bridge erection, etc. A paper on "New Freight Yards of the Illinois Central R.R.," by S. S. Roberts, was read by title. Two very interesting lectures were given as a part of the program, both of them being illustrated profusely by lantern slides; one was by Prof. I. O. Baker, on "The Panama Canal," giving not only a general description of this great work, but also notes of his own recent visit to the work; the second was on "The Keokuk Water Power Plant," by Hugh L. Cooper (Keokuk, Ia.), who is vice-president and chief engineer of the power company. This plant and its construction have been described very fully in Engineering News.

The election of officers resulted as follows: President, J. A. Harman, Peoria, Ill.; vice-president, L. K. Sherman, Chicago; secretary, E. E. R. Tratman, Chicago. The next meeting will be held at Chicago in January, 1913.

## The Opportunity of an Association of both Contractors and Engineers*

By Maj. C. E. Gillette.†

I think every man should try to do something for the public benefit. I think a society such as this, properly organized and united, can do a vast amount of good in correcting abuses in public contracts, and it is this which gives me my interest in the society.

This is the first attempt to organize contractors engaged in engineering work. The amount of benefit that can accrue to the business of the engineering contractor by organization is so evident, from the experience of every other class of business men, that it is astonishing that no organization has been attempted before.

One of the fields in which this society of combined engineers and contractors can do much good work is in the prevention of waste and lost motion in construction. Most engineers and architects design their work with the view of what it will be like when completed. Very few design it also from the other point of view, the cost of doing it.

This is the age of conservation, and we should, in so far as we can, conserve the money wasted in contracts on designs much more difficult of construction than those necessary to meet the same ends. If the Government plans an improvement on a river, costing $1,000,000 more than necessary to make the improvement economically, that money is lost, which might be used on another contract.

One great cause of loss is the lack of harmony between the engineer and the contractor. We should get together; methods of construction should be one of our principal objects in coöperation, to get the engineer to look at his structure from the contractor's point of view as well as the point of view of the finished work.

The inspector and the contractor should be reduced more to a common demoninator. An enthusiastic young inspector can cause the contractor great loss. I remember a case in point. I was building a lock for the Government. One day I found the contractor tearing his hair. The young inspector had ordered a good cut stone block removed from the wall, a beautiful piece of stone, set to perfection; but in setting it a small corner had been knocked off, and the inspector proposed to take out that stone and replace it.

That inspector thought he was saving the Government so much money; but the real result of his action would have been to add 10% to that contractor's bid on another piece of work. This society should take up the subject of inspection as well as that of specifications.

It would be well for the society to confine itself to a few fairly broad subjects. Let us take one subject and get the consensus of opinion, the experience, the observed facts, of all the members on it; and when we come to the end of the year we shall have accomplished something. Otherwise the field is so vast that we can only make a dot here and a dot there.

The following subjects have occurred to me as being an ample arrangement of our year's work. Fair specifications, primarily in public contracts, is a subject which has already been started upon. If this society succeeds in getting on the statute books of one state, a good complete law that will require fairness and avoidance of favoritism and graft, or favoritism for graft, in public contracts, government, state and municipal, it will have justified its existence over and over again.

We ought to have all the experiences of all the members and their friends who have had unsatisfactory experiences, unfair treatment, vague specifications, tricky specifications, graft specifications, foolish specifications—all those things which make public bidding unsatisfactory and unfair. We want to stop that kind of business.

The amount of intolerable things the contractor stands is enough to make his hair gray. But we as a society can move on these things without being damaged individually, as one of our members has said would be the case if he brought out all the facts of his own experience. Send the facts in these cases to the society. As president of this society I will agree to push to the front every disagreeable case of that kind. We will publish them, and we will use them before committees of the legislature, and we will get a law through somewhere that will, in some one state, or some one city, at least, make it possible for any honest man to put in an honest bid on an honest contract and get decent treatment.

The next point is to get practical specifications. I have seen specifications that would require a miracle to carry them out; an absolute impossibility. Contractors meet with such conditions all the time.

Another point, already touched on, is to furnish the society with ammunition to criticise wasteful contracts and wasteful specifications. Good engineering is that which accomplishes a certain object for the fewest dollars. Anything dif-

*Abstract of the presidential address of Maj. Cassius E. Gillette, before the American Society of Engineering Contractors, Jan. 9, 1912.

†Consulting Engineer, Philadelphia, Penn.

ferent from that is against the interests of both contractors and engineers.

The subject of cost data is a difficult one. A contractor present at our afternoon meeting stated that he would not give away his collection of cost data, as rivals would get it and beat him in bidding. While some contractors have published cost data, it cannot be expected that the practice will be generally followed. So while it should be a very important function of this society to gather data of the costs of various work, mere figures mean nothing; complete details as to how the work was done are necessary, and it is important for us to gather such information.

However, we must rely upon the engineer members rather than the contractors for gathering such data. It is no loss to a contractor for an engineer to state that the contractors he once worked with had a certain method of doing work. The engineer is free to publish complete details, and the great importance of this as a means of increasing efficiency is everywhere recognized.

## Papers on Timber Preservation

At the annual meeting of the Wood Preservers Association, held in Chicago on Jan. 16 to 18, there was an exceptionally good list of papers. We present herewith a general review of these papers, grouped according to the principal subjects discussed. Abstracts of some of the papers will be printed later.

### Treated Railway Ties

In a paper on "Cutting and Seasoning Timber," by A. Meyer (Supervisor of the Tie Plant of the C. B. & Q. Ry.), reference was made to the necessity of using larger quantities of wood of inferior quality: hard and soft maple, gum, sycamore, birch and beech. These are not satisfactory unless treated, and on account of their tendency to decay while seasoning, a successful seasoning is necessary to make the ties worth treating. He pointed out that it is of little use for the consumer to purchase material and go to the expense of having it treated unless the material is worth this expense. The question was dealt with also in a paper on "Treating Seasoned and Unseasoned Ties," by F. J. Angier (Superintendent of Tie Preservation, B. & O. R.R.). He presented figures showing that a plant treating 1,800,000 seasoned ties per year could treat only 1,200,000 untreated ties, and the cost per tie would be 18.15 c. and 19.48 c., respectively. Further, with untreated ties and treated ties having a life of 6 and 12 years, the average cost per tie for a 12-year period would be 15.7c. and 11.3c. respectively.

In a third paper, on "The Production of the Wood Cross Tie," A. R. Joyce (Joyce-Watkins Co.) remarked that as 80% of ties are hewed, the hewed tie should be given most attention. He outlined the method of producing ties (the cutting, piling, hauling, rafting, inspection, etc.). He suggested that the managers of railways and commercial treating plants should get together in the preparation of uniform standard specifications for the preservative treatment of ties, but he made no reference to the work done in this direction by the American Railway Engineering Association.

### Creosoted Wood Block Paving

A paper on "Creosoted Wood Paving Blocks," by A. E. Larkin (General Superintendent, Republic Creosoting Co), was of a rather general chartcter. He suggested that the inspection of blocks should be made only on the work, excluding the prior inspection at the treating plant which is sometimes required. As to sap wood, he considered that this can be used with success and that the increasing price of heart wood will make the use of the former necessary. Paving blocks must be treated not only to prevent decay but also to make them waterproof, which requires a heavier treatment than that which is sufficient to protect railway ties against decay. As to the engineer's side of the case, he thought (1) the engineer should consider the manufacturer and the contractor in preparing his specifications, and (2) he should pay more attention to the thickness and even surface of the concrete, and not hold the block manufacturer responsible for defects in pavement which are due to defective foundation.

Generally similar views were expressed in a paper on "Wood Block Pavement from the Construction Standpoint." by Day I. Okes (Kettle River Co.). The concrete base should be of ample strength (reinforced with steel when relaid over a trench), and its surface should be finished with a template. The sand cushion should not exceed 1 in., and ½ or ¾ in. is sufficient where the concrete has a smooth finish. Where there is vibration (as between car tracks) a mortar cushion is preferable; this is laid dry, and when the blocks are laid the pavement is flushed with water. One objection to this is the time which must be allowed for the mortar to set. In his opinion the blocks should be laid at an angle of 45 to 67½° with the curb.

### Quality of Creosote Oil

The importance of the quality of the oil in relation to the efficiency of creosoting, and the desirability of arriving at some uniform specifications for the oil, were matters discussed in no less than four papers. This is some evidence of the amount of thought now being given to these questions on the part of the makers and users of the oil and the users of creosoted wood. A paper on "Evaporation of Creosote and Crude Oils," by P. E. Fredendoll (Chemist, A. T. & S. F. Ry.), pointed out that the evaporation of oil from treated wood is greater than is generally conceded. Ties treated in 1904 and laid in 1905 were examined in 1911, and found to contain 30 to 66% of the original amount of oil; ties carefully treated for experimental purposes in 1908 and tested in 1911 showed only 44% of the oil originally absorbed. Piles treated in 1898, showed only 20% of the oil left in 1911. Experiments indicate also that the evaporation is not reduced by the addition of crude oil, but the author suggested further investigation to find some oil or tar that will have this effect.

This question of evaporation was dealt with also in a paper on "Creosote Specifications and Analysis," by Herman von Schrenk (Supt. of Timber Preservation, C. R. I. & P. Ry.). He stated that the higher the percentage of low-boiling factions the greater the percentage of evaporation. The subject is of particular importance in relation to processes which use small quantities of oil, and in which any loss of this oil from the wood is more serious than when heavier injections are given.

A review of several specifications for creosote oil, including those of the American Railway Engineering Association and some foreign railways, was given by S. R. Church (Chemist, Barrett Mfg. Co.) in a paper on "Specifications and methods of Analysis of Creosote Oil." He suggested that the requirements of the Am. Ry. Eng. Assoc. specifications (the most widely known and widely used) are unreasonably high, especially in demanding oil of specially high-boiling character. They exclude many American oils, and are higher than those obtaining on European railways; and "from the standpoint of antiseptic efficiency the highest boiling portions of the coal-tar creosote are not as effective as the middle boiling portions." On the other hand, Mr. Von Schrenk, in the paper already noted, upheld these particular specifications and stated that European railway officers approve them. As to excluding certain oils, he thought that was no reason for lowering the specifications, but rather for producing more oil of suitable quality.

In a paper on "Creosotes and Creosoting Oils," Mr. David Allerton (Kettle River Co.) referred to the too general application and generally vague meaning of the term "creosote." He suggested that the dead-oil of coal tar should be designated creosote; other creosotes should be distinctively named wood creosote, oil-tar creosote, etc. Mixtures of creosote with various kinds of tar should be designated creosoting oils; the specifications for such oils should state the percentage of creosote contained and the percentage and kind of matter added. He

also deprecated the use of oil of high viscosity, which not only makes the treatment more difficult, but (in his opinion) accounts for the excessive exudation of oil from paving blocks.

### Treated Timber for Boats and Barges

In a paper on "Economic Materials for Boat and Barge Construction," by A. E. Hageboeck (Inspector in Charge of Creosoting Operations, U. S. Engineer Office, Rock Island, Ill.), it was pointed out that for modeled steamship hulls steel gives more economical results than treated timber, owing to the necessity of cutting and framing timbers during erection. But for boats and barges of the "scow" type the timber can be framed and bored before treatment. A steel barge will cost three to four times as much as one of untreated fir and nearly three times as much as one of creosoted timber.

The Southern yellow pines and Douglas firs are the only two classes now available for this class of work, and (on the Lower Mississippi River) a barge of untreated pine with the minimum of sappy timber is past economical repairs in 10 years. Barges of pressure-treated pine have been in use for 12 years and are good for 10 years more. Barges of untreated Douglas fir show decay in a few years, but those on the upper Mississippi (used by the U. S. Engineer Office) average a life of 15 years, although the increased maintenance cost makes 10 or 12 years the economical limit. The life of these barges of creosoted fir is estimated at 20 years. The average cost for different materials is given in the accompanying table.

TABLE OF COST OF RIVER BARGES
(100x20x4 FT. 7 IN.)

| Material | Life years | Cost (dollars) Original | Total* | Per year |
|---|---|---|---|---|
| Creos. fir, 10 lb.. | 20 | 1500 | 3427 | 171 |
| Cre. y. pine, 14 lb. | 22 | 1650 | 3892 | 177 |
| Untreated fir.... | 15 | 1200 | 3225 | 222 |
| Untreated pine... | 15 | 1300 | 3500 | 233 |
| Steel ..... | 25 | 4000 | 9427 | 377 |

*Including repairs and 5% interest on first cost and repairs.

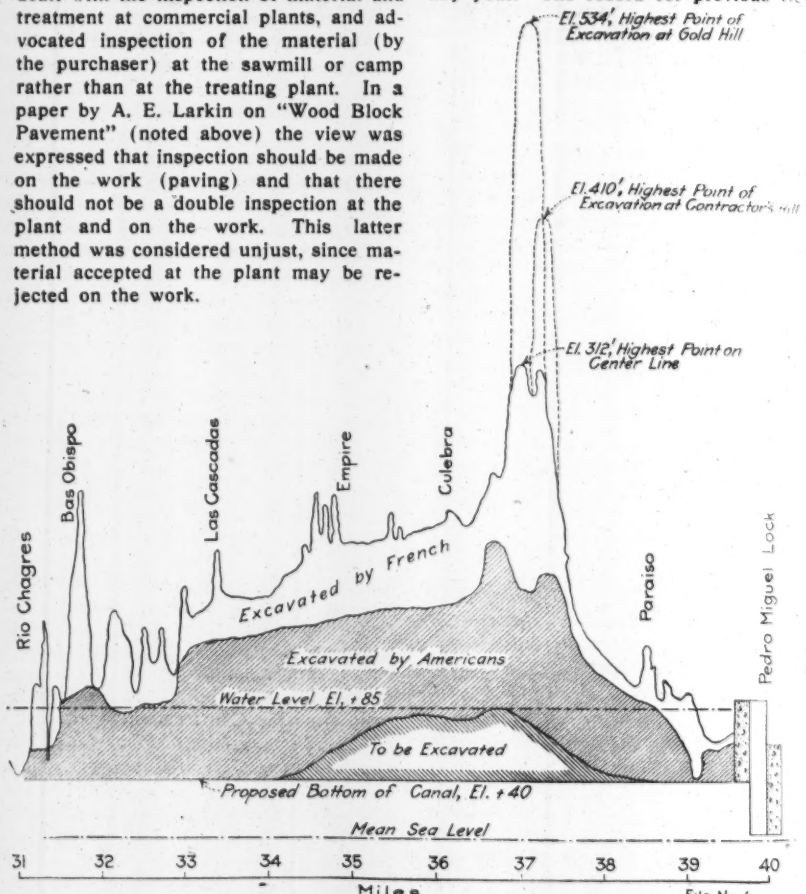
### Other Papers

*Treatment of Poles*—A paper on "The Preservation of Power Transmission Poles," by W. R. Wheaton (Fresno, Calif.), reviewed the experiments made by the San Joaquin Light & Power Co., which company has now established its own plant for the treatment of the butts of poles with creosote by the open-tank process. We shall publish an abstract of this paper.

*Operation of Timber Treating Plants*—Three papers dealt with this subject in regard to railway and private plants. The paper on "Scientific Management of Timber Preserving Plants," by D. Burkhalter (Superintendent of the plant of the Buffalo, Rochester & Pittsburg Ry.), related largely to the question of labor and the advantages of having a crew of skilled workers; also the arrangement of the tie-handling gang to insure full efficiency. The effective control of the operation of the treating process was included. Of a similar character was a brief paper by E. A. Sterling (Forester, Pennsylvania R.R.), who referred to economic methods and mechanical devices in the unloading, piling, loading and shipping of ties. R. L. Allardyce (Supt., I. C. & C. Co., Texarkana, Tex.) dealt with the inspection of material and treatment at commercial plants, and advocated inspection of the material (by the purchaser) at the sawmill or camp rather than at the treating plant. In a paper by A. E. Larkin on "Wood Block Pavement" (noted above) the view was expressed that inspection should be made on the work (paving) and that there should not be a double inspection at the plant and on the work. This latter method was considered unjust, since material accepted at the plant may be rejected on the work.

## Culebra Cut, Panama Canal, Excavation in 1911 and to Date

The excavation in Culebra Cut in December, 1,351,082 cu.yd., was the greatest accomplished in any December of the eight since the American canal work was begun. It brought the total for the year up to 16,596,891 cu.yd., and this is the greatest that has been accomplished in any year. The record for previous Decembers, and for previous years, compared with December, 1911, and the year 1911, follows:




PROFILE OF THE CULEBRA CUT, PANAMA CANAL, SHOWING PROGRESS OF EXCAVATION TO JAN. 1, 1912

(Lowest cut is in drainage ditch, but is only a single cut.)

EXCAVATION IN CULEBRA CUT, DECEMBER, 1904 TO 1911

| December | Cu.yd. |
|---|---|
| 1904 | 42,935 |
| 1905 | 70,630 |
| 1906 | 307,689 |
| 1907 | 1,025,485 |
| 1908 | 1,210,046 |
| 1909 | 1,152,022 |
| 1910 | 1,211,400 |
| 1911 | 1,351,082 |

EXCAVATION IN CULEBRA CUT, YEARS, 1904 TO 1911

| Year | Cu.yd. |
|---|---|
| 1904 | 243,472 |
| 1905 | 914,254 |
| 1906 | 2,702,991 |
| 1907 | 9,177,130 |
| 1908 | 13,912,453 |
| 1909 | 14,557,034 |
| 1910 | 15,398,599 |
| 1911 | 16,596,891 |
| Total | 73,502,824 |

**Two Railroad Lines** were built by the city of Los Angeles, Calif., for use in inspecting the Los Angeles Aqueduct. One of these lines was a standard gage, 8.5 miles in length, and was operated by the Aqueduct forces for two years, after which it was dismantled and sold to the U. S. Reclamation Service. During the operation of this line 42,300 tons of freight were hauled at a cost of 10c. per ton mile. The road was built to avoid the excessive haulage cost by teams. A narrow-gage line, 4281 ft. in length, was built to the cement plant owned and operated by the city, and also another narrow-gage line, 8000 ft. in length, to the site of the Haiwee Dam, the latter for use in hauling rock and dirt. The rolling stock consists of 18-ton engines and 4-yd. rocker dump cars. William Mulholland is chief engineer, and J. B. Lippincott is assistant chief engineer of the Los Angeles Aqueduct.

There remain to be excavated 15,941,181 cu.yd., and the work in this part of the Canal is thus 82% completed as is shown graphically by the accompanying figure.

The high record of excavation in December is due to the fact that there has been very little rainfall in the territory of Culebra Cut during the month, which is ordinarily considered one of the rainy season months.

Since December, 1907, the excavation has fallen below the million-yard-a-month mark only once, and the rate at which it has advanced during the year just closed is shown in the following statement:

| Months | Cu.yd. |
|---|---|
| January | 1,356,394 |
| February | 1,409,338 |
| March | 1,728,748 |
| April | 1,414,336 |
| May | 1,299,100 |
| June | 1,401,016 |
| July | 1,337,833 |
| August | 1,442,402 |
| September | 1,340,173 |
| October | 1,306,971 |
| November | 1,209,498 |
| December | 1,351,082 |
| Total | 16,596,891 |

The work in December was done by 40 steamshovels.—"Canal Record," Jan. 3, 1912.

## A Decision on the Hurry & Seaman Patent on the use of Powdered Coal Fuel in Rotary Cement Kilns

A patent decision of great importance to the cement industry, and of special interest, also, to those interested in patent-law practice, was recently made by the U. S. Court of Appeals for the seventh circuit. The decision affirms the judgment of the lower court which refused to sustain the patent issued to Hurry and Seaman for apparatus to burn powdered coal in a rotary cement kiln.

It is common knowledge that the strength of this patent has been relied upon by those who sought to carry out a plan to effect general control of the cement-making industry under one organization. Had the patent been sustained with the breadth that its owners hoped, it would have been possible under it to have controlled the use of powdered coal for burning cement.

In the suit the Atlas and North American Portland Cement Companies, owners of the Hurry and Seaman patent, No. 645,031, brought suit against the Sandusky Portland Cement Co. for infringement of the patent. The case was prosecuted on both sides with great diligence. Some two thousand pages of testimony were taken and the argument in the case occupied some 600 pages. Judge Baker, who delivered the opinion of the court, reviewed the state of the art and showed how, in the early development of the rotary kiln for burning cement, oil was used as a fuel. The Atlas company, of which Hurry and Seaman were employees, undertook to cheapen the cost of fuel by substituting powdered coal for oil, and were, from the showing of the suit, the first to burn powdered coal with commercially successful results in rotary kilns.

The particular method and apparatus which they used were described in the patent to Hurry and Seaman, which was filed Feb. 12, 1896, and issued Mar. 6, 1900. Other cement makers, however, when they found it desirable to introduce the use of powdered coal did not find it necessary to copy the Atlas method and apparatus. As Judge Baker says: "For this purpose they could turn to the known prior art coal injectors." A large amount of work had been done and many patents had been filed on the use of powdered coal for feeding boiler furnaces, and patents had been issued to Siemens and Crampton for powdered-coal burners in connection with rotary kilns. Judge Baker continues:

> There were the appliances, and the desired result was known. How attain it? Cut and try. And so these men, skilled in the art of calcining cement materials in their rotary kilns by the use of oil injectors, tested the interdependent matters of coal feed and air supply, as above suggested, and presently their experience as practical cement burners gave them control of the operative relations between their existing rotary kilns and the coal injectors of the McAuley and Westlake types. On the average about 90 days were required to achieve the final adjustment of the parts and the ultimate control of the flame. And not one instance of failure is recorded.

It is frequently said when the courts fail to sustain an important patent, such as the one here considered, that it evidences a weakness of the patent system.

On the contrary, we believe it shows the strength and soundness of the patent system as at present administered.

Hurry and Seaman, Judge Baker states, were the first to burn powdered coal in rotary cement kilns with commercial success. But the patent of limited scope which was granted to them for the particular apparatus and method which they used could not be permitted to shut off the public from its right to take common knowledge and common skill and adapt other devices to produce the same result.

**Elevated Railway Track** construction is being modified slightly in relaying the deck and track of the elevated loop line in Chicago. The new ties are laid 3 in. apart (instead of 10 in. as formerly), and no tie-plates are used. The new 80-lb. rails are laid with as small an expansion spacing as practicable, and the joints are spliced with longer angle bars than those formerly used. When the track is new it will probably reduce the noise now caused by trains, and about which there has been so much complaint; but it has not been designed with this end in view, and has no special noise-reducing features.

## A Bridge Collapse Due to an Underwashed Pier

A railway accident on the French Government Railways on the line between Angers and Poitiers, which occurred on Nov. 23, 1911, was reported in Engineering News, Nov. 30, 1911, p. 665. Since that time various official inquiries into the cause of the accident have been instituted and a number of prominent engineers in France have given their services towards investigating the cause of the accident. The reports from these commissions are not yet available, nor is it probable that the Government will ever make them public, but in the Dec. 23, 1911, issue of "Le Genie Civil," Mr. J. Latrè describes in some detail the accident and the probable causes. From that account we have made the following notes.

A short line of the French Government Railways running between Angers and Montreuil-Bellay passes about two miles outside of the latter city through the valley of the Thouet River, a branch of the Loire. This crossing is made on a long fill, some 10 ft. high, and a 200 ft. two-span bridge over the river proper. The whole line and the bridge were built in the late '70's and have not been changed materially since, though the bridge superstructure may have been strengthened from time to time to meet the increase in weight of rolling stock. The Thouet River is subject to very sudden rises, one of which, starting in the last part of November, 1911, reached its climax on Nov. 22, when it attained a height greater than ever before in the history of the river. At the time the water level was only a few inches below the track, which had been originally placed at an elevation about 5 in. higher than the highest known flood.

This flood, of course, alarmed the track employees in the vicinity and warnings were sent out on the 22nd to all trains. On Nov. 23 a train, composed of two light locomotives and nine cars, was stopped at the station before crossing the valley and was boarded by three track inspectors, two of whom rode on the forward locomotive to warn the engineer of any possible defection or danger in the track ahead. The train passed safely over the fill and over the first span of the bridge, but the second span suddenly gave way, precipitating all but the four rear cars into the river. Some of the passengers in the cars managed to crawl out through the windows onto the outside of the cars which were stranded in the shallow water, but at least 14 were drowned. The exact number was not known when the article in the "Le Genie Civil" was written because the flood was still too great to permit entrance into one of the submerged cars. The estimate of the dead was made

from the number of ticket-holders known to be on the train.

An investigation of the site of the accident after the collapse showed that the middle pier, supporting the inner ends of each of the bridge spans, had overturned, allowing the spans to fall into the river. This pier was of masonry resting on a solid concrete block, which in turn rested on gravel dumped into a sheet-pile coffer-dam. The coffer-dam was formed by driving the sheet-piles into a very weak stratum in the river bottom. Investigation shows that the bottom of the concrete block, that is the top of the gravel fill, was higher than the bottom of the river, so that the only protection that the pier had was given by the outside sheet piling and by some riprapping which had been deposited on the outside of the piles. It appears certain that the high water in the river with its consequent high velocity washed away the surrounding supports to the pier and undermined it to such an extent that it was unable to carry the load of the bridge and the train.

Mr. Latrè states that at least twice before a bridge at this same site has failed from practically the same cause. In 1798 the middle arch of a similar bridge was undermined and collapsed and in 1809 a masonry arch bridge was washed away. In spite of this disastrous history, the builders of the present bridge seem not to have taken proper precaution to guard against further undermining. It has so happened that never before in the history of this bridge has the flood been so high as at the time of the recent accident, which may possibly account for the stability of the structure through the past 35 years. According to the article from which we have taken this note, considerable criticism has been directed against the Government Railway system on account of the lack of effective inspection of the pier. It would seem that the dangerous condition would have been evident to any inspection by divers. This critical attitude is heightened by the fact that the same line was the scene of a somewhat similar accident on Aug. 4, 1907, when a train on its way from Angers, crossing the bridge across the Loire, broke through the floor system and falling into the river caused the death of 27 persons. This accident was described in ENGINEERING NEWS, April 9, 1908, p. 390.

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**The Municipal Collection and Disposal** of rubbish and ashes in St. Louis, Mo., is urged by the Civic League of that city. The League states, in its bulletin of Jan. 8, 1912, that the service as rendered privately now costs the city a half million dollars a year and that the work might be done by the city, under its Street Department, for $170,000 a year. Authority for municipal collection exists; an appropriation is all that is necessary to start the work.

**The Bursting of a Mold** in the French naval arsenal near Angouleme, France, Jan. 9, caused the death of eight molders.

**A Blast Furnace Collapsed** near Duisburg, Germany, Jan. 15, according to press reports and caused the death of eight workmen.

**An Explosion of Illuminating Gas,** Jan. 17, wrecked a three-story brick tenement building at Cincinnati, Ohio. One person was killed and six others were badly injured. The accident is ascribed to the ignition of gas, which had accumulated in the cellar, by a lamp carried by a man who went after a bucket of coal.

**More Explosions in New York City** sewers occurred on Jan. 22. These were more severe and extended over a greater territory than those reported in our issue of Jan. 18, though evidently of the same character and due to the presence of gasoline (from cleaning establishments and automobile garages) in the sewers. It is reported that 30 manhole covers were blown off in the district between Third Ave., East River, Thirty-first and Thirty-sixth Sts. In some places black smoke poured from the open manholes and there were lighter explosions about 15 minutes later. Half the manhole covers were smashed or lost and police reserves had to be called out to guard the openings. Several truck runaways were caused; a flying cover tore a hole in a Second Ave. car near Thirty-second St.; the motorman on a Thirty-fourth St. car was thrown from his platform against an elevated-road pillar; gas mains and telephone lines were damaged; and a number of persons were injured by the manhole covers and broken glass.

**A Locomotive Boiler Explosion** wrecked passenger train No. 40 on the Chicago, Burlington & Quincy R.R., Jan. 14, eight miles west of Seward, Neb. One trainman was injured. Reports state that the locomotive and three coaches left the track.

**A Rear Collision** on the Illinois Central R.R., at Kinmundy, Ill., Jan. 22, caused the death of James T. Harahan, former president of that road, who was retired on a pension a few months ago. The three other victims of the wreck were E. B. Peirce, General Solicitor of the Chicago, Rock Island & Pacific Ry.; E. E. Wright, son of Gen. Luke Wright, former Secretary of War, and Frank O. Melcher, Second Vice-President of the Chicago, Rock Island & Pacific Ry. Obituary notes of Mr. Harahan and Mr. Melcher are printed elsewhere in this issue.

The four men killed were in Mr. Melcher's private car, which was coupled to the rear of train No. 25. This train was held at Kinmundy by the stopping of a freight train ahead of it to take water. Reports state that a flagman sent back from No. 25 was not in time to stop express train No. 3. The locomotive of No. 3 demolished the private car on the rear of the train ahead. No other cars were much damaged, although, according to reports, train No. 25, in spite of its set brakes, was driven about 200 ft. along the track.

A similar accident occurred on the Southern Ry. at Lynchburg, Va., Nov. 29, 1906, when President Samuel Spencer, of that railway, and three of his friends were killed in a rear collision that demolished Mr. Spencer's private car.

**A Butting Collision** at New Cast[le], Penn., Jan. 15, between two passeng[er] trains killed five trainmen. Repor[ts] state that an eastbound Baltimore [&] Ohio R.R. train crossed over through [an] open switch to the Pittsburgh & La[ke] Erie R.R. track, where it collided wi[th] a westbound Pittsburgh & Lake Er[ie] train.

**A Butting Collision** between a regular passenger train and a special on the Louisville & Nashville R.R., Jan. 16, near Long Run, Ky., caused the death of four men. Reports state that 100 passengers were more or less seriously injured. The special, consisting of a locomotive and two coaches, was a Chesapeake & Ohio Ry. train running back empty from Louisville to Lexington over the Louisville & Nashville tracks. The other train had four coaches. They met on a sharp curve. The accident is ascribed to a misunderstanding of orders.

**A Record Story of Rail Breakage**—Aberdeen, S. D., Jan. 11—Traffic is demoralized on the Chicago, Milwaukee & St. Paul R.R., between here and Milbank. A "flat" wheel on a passenger coach broke 900 rails between the two points. Trains are halted, while railroad crews are working frantically to repair the damage. The extreme cold made the rails brittle.—New York "World," Jan. 11.

We print the story because it is a good story and not because it bears the earmarks of truth. As the distance between Aberdeen and Milbank is nearly a hundred miles, the average damage would be nine broken rails per mile. One is curious to know what the wheel can have been made of to have punished the track so severely without being itself knocked out. The passengers who rode a hundred miles over that flat wheel must feel that the railway got its deserts!

**Statistics of Accidents in New York** city streets caused by automobiles, wagons and trolley cars are given in the annual report of the National Highways Protective Society. In the year 1911 such accidents killed 423 persons and injured 2004 others. The figures for 1910 were 376 killed and 930 injured.

Automobiles in 1911 caused 142 deaths and 1031 injuries; trolley cars, 109 deaths and 604 injuries; wagons, 172 deaths and 369 injuries. Of the deaths caused by automobiles, only four were due to public taxicabs.

**A Coal Mine Explosion,** at Kammerer, Wyo., Jan. 20, killed five men and badly injured nine others. The accident occurred in mine No. 4 of the Kammerer Coal Co.

**An Exhibition Aviator,** Rutherford Page, of New York City, was killed at Los Angeles, Calif., on Jan. 22, by a fall of 75 ft. His machine, a Curtis biplane, was capsized by eddy currents above rough ground and his skull was crushed by the impact of his engine.

Lieut. Boerner, of the French army, died at Senlis, on Jan. 21, from injuries received on Jan. 19. The flyer capsized at a height of 300 ft., and the fuel tank of the wrecked machine exploded, burning the aviator, who was strapped to his seat.

An amateur aviator, named Alfred Wagner, was killed in a practice flight at Paris, Jan. 20.

**The Annual Report of the International Waterways Commission** refers briefly to the proposed dam at the outlet of Lake Erie to control its level. Surveys and studies of the Niagara River from Niagara Falls to Lake Erie have been in progress during the year, and the field work has practically been com-

pleted. Study has been given to the location and design of the proposed dam, but the work is not yet finished. A final report is expected to be made, however, during the coming year.

**The Key West Extension** of the Florida East Coast Ry. was formally opened on June 22, by the first through passenger train from the main line to Key West. This train bore a notable company of railroad men, congressmen, and army and navy officers, including the president of the road, Henry M. Flagler, Assistant Secretary of War Oliver, Senators Fletcher and Chamberlin, the House Committees on Military Affairs, Naval Affairs, Rivers and Harbors, Gen. W. H. Bixby, Rear Admiral H. I. Cone.

Construction of this line was started in April, 1905, and in Jan., 1908, the extension was opened as far as Knight's Key. It leaves the mainland near Homestead, Fla., and passes over a chain of keys along the coast on fills, viaducts and bridges. Among the notable features are the Long Key viaduct (2.7 miles of concrete arches), the Knight's Key viaduct (7.2 miles) and the Moser Channel drawbridge. Various features of the work have been noted in Engineering News, Oct. 19, 1905, May 9 and Oct. 10, 1907, Jan. 16, 1908, May 20, 1909.

**The Tunnel under the Hudson River** at Storm King, N. Y., being driven by the Board of Water Supply of New York City for the Catskill Aqueduct, is to be holed through on Jan. 30. The advance headings have approached within communicating distance of each other.

**The Committee on the Unification of** portland cement specifications, noted in our issue of Sept. 7, 1911, p. 301, has just issued a preliminary statement relative to the present status of the efforts of the United States Departmental Committee to secure agreement on a single uniform specification for portland cement for the United States. This committee, originally consisting of representatives from the various departments of the United States service, met in the spring of 1911 with a view to securing an agreement among the various branches of the Government in the matter of cement specifications. At the preliminary meeting it was decided to call in representatives of the various interested technical societies, and an acceptance from each of the societies was received soon after. On Nov. 24 a general meeting was held at Washington, D. C., to which representatives of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association, the Board of Engineer Officers, United States Army and the aforesaid Departmental Committee were invited. At this first meeting the American Society for Testing Materials was not represented. However, at a later meeting on Jan. 8, 1912, all of the members were represented and progress was made toward a uniform specification. At this meeting the representatives of the American Society of Civil Engineers expressed preference for retaining the Vicat needle for determining normal consistency and time of setting, but offered in compromise to accept the Ball method as a means of determining normal consistency, if the Government representatives would accept the Vicat needle as a method of determining the time of setting in place of the Gillmore needles. The Government representatives considered these points of issue, but they became convinced that the Gillmore needle should be used, for reasons set down in the report. In consequence, a full agreement was not reached at the meeting, although in general the specification was accepted by all members present. With a few minor changes, the revised specification was approved by the Departmental Committee and by the Board of Engineer Officers, United States Army, and recommended for adoption as a United States Government specification for portland cement. It is believed that when the point of difference regarding the Gillmore and the Vicat needle is settled that a full agreement will be reached between the Governmental representatives and the representatives of the societies which, up to the present, have issued the uniform specification for cement most used in this country.

**Comparative Tonnages of the Navies** of the chief naval powers of the world are given in a bulletin issued Dec. 1, 1911, by the U. S. Office of Naval Intelligence, as follows:

| | Tonnage of completed vessels | Tonnage, including vessels now building. |
|---|---|---|
| Great Britain | 1,896,149 | 2,324,579 |
| United States | 757,711 | 885,066 |
| Germany | 749,699 | 1,087,399 |
| France | 630,705 | 741,425 |
| Japan | 421,369 | 590,119 |
| Russia | 297,819 | 473,879 |
| Italy | 203,812 | 312,122 |
| Austria | 167,993 | 267,442 |

In case the vessels under construction were now completed, the United States would exchange places with Germany, dropping from second to third place, while the other nations would keep their same relative positions.

**The Use of Common Towels in New** York City has been prohibited by an amendment to the Sanitary Code adopted by the Board of Health on Jan. 5, 1912. The prohibition applies to public lavatories, washrooms and public comfort stations maintained by any person, firm or corporation, in connection with any railroad station, ferry house, school, hotel, theater, concert hall, dance hall, department store, café, restaurant or beer, wine or liquor saloon. The "common" towel is defined as meaning any towel used by more than one person. The word "corporation" includes municipal as well as private corporations.

**Red Water Troubles at Charleston, S. C.,** in connection with the water supply of the Charleston Water & Light Co., were briefly discussed by Rudolph Hering in a report on possible municipal water-works made by him in behalf of the city in the latter part of 1911. The supply is taken from Goose Creek after prolonged storage, and passed through mechanical filters. Mr. Hering states that "the typhoid statistics of Charleston do not indicate a serious, if any, sanitary defect in the present supply. He continues:

> Taste, Appearance and Chemical Qualities: Under this heading we have the main objections which have been made to the quality of the present supply, and which are the causes of the agitation to get a better supply. There are at times an objectionable taste and odor to the water, which it seemed difficult to remove. The water has sometimes been slightly turbid and it has caused a rusting of the distribution pipes, and also of pipes and boilers within the buildings.
>
> There has been some difficulty in finding the best treatment of this water, to filter and purify it without adding other objectionable conditions. Recently experiments have been made by the water company to increase the alkalinity of the water, so that the action of the sulphate of alumina would be more satisfactory. It was found that if the water was not thoroughly filtered and all color removed the remaining organic matter in the water had a corrosive effect. If an excess of sulphate of alumina was added and all color removed the water had a high corrosive effect. Until recently the water company states that it had been using sulphate of alumina up to about 1¾ grains per gal., an amount sufficient to almost prevent the corrosive effect due to the organic matter in the water. This did not remove all the color and recently they have been using 2 grains of sulphate of alumina, after which the water is filtered and an alkali, such as soda ash or hydrate of lime, then added. With this new method of procedure they state that the corrosive effect of the water is entirely neutralized.

## Personals

Mr. L. S. Berg, President of the New Orleans, Mobile & Chicago R.R., has resigned.

Mr. Stoddard Jess has resigned as President of the Harbor Commission of Los Angeles, Calif., because of the pressure of private business.

Mr. W. A. Cross, formerly of the Warren Bros. Co., of Boston, Mass., has become a member of the Concrete Engineering Co., 141 Milk St., Boston, Mass.

Mr. H. G. Smith, formerly Assistant City Engineer of Salt Lake City, Utah, has taken a position in the engineering department of the Oregon Short Line R.R.

Mr. W. F. Owen, Vice-President and General Manager of the New Orleans, Mobile & Chicago R.R., has been elected President of the same, succeeding Mr. L. S. Berg, resigned.

Mr. L. W. Rundlett, M. Am. Soc. C. E., recently Commissioner of Public Works of St. Paul, Minn., has accepted a position as Commissioner of Public Works of Moose Jaw, Sask., Canada.

Mr. John Duder, Assoc. M. Am. Soc. C. E., formerly Chief Engineer of the Birch Construction Co., of Salt Lake City, Utah, has been appointed Assistant City Engineer of Salt Lake City.

Mr. John M. Diven, Secretary of the American Water Works Association, and until recently Superintendent of Waterworks of Charleston, S. C., has accepted a similar position at Troy, N. Y.

Mr. Ward Crosby, Principal Assistant Engineer of the Carolina, Clinchfield & Ohio Ry., has been promoted to Chief Engineer, succeeding Mr. M. J. Caples, M. Am. Soc. C. E., whose resignation was noted in our issue of Nov. 2, 1911.

Mr. Robert I. Todd, Assoc. Am. Inst. E. E., Vice-President of the Indianapolis Traction & Terminal Co., Indianapolis, Ind., has been elected President of the same, succeeding the late Hugh J. McGowan.

Mr. G. H. Herrold, recently Engineer of Maintenance-of-Way of the Chicago Great Western Ry., at St. Paul, Minn., has opened an office in the Hackney Bldg., St. Paul, for the general practice of engineering.

Mr. L. H. Phetteplace, formerly Superintendent of the Carolina, Clinchfield & Ohio Ry., at Erwin, Tenn., has been promoted to General Superintendent of the same railway, in charge of operation and maintenance. His headquarters will remain at Erwin.

Mr. L. K. Sherman, M. Am. Soc. C. E., has resigned his position as Assistant Chief Engineer of the Sanitary District of Chicago, Ill., to become associated with Mr. George Donnersberger, under the firm name of L. K. Sherman & Co., Engineers and Contractors, Chicago, Ill.

Messrs. Hartley R. Church and Charles E. Beugler, Assoc. Ms. Am. Soc. C. E., have severed their connection with the firm of Haviland & Tibbetts, Consulting Engineers, San Francisco, Calif., and established an office in the Macdonough Bldg., Oakland, Calif., under the firm name of Church & Beugler.

Mr. E. L. Cousins, Assoc. M. Can. Soc. C. E., has been appointed Harbor Engineer of Toronto, Ont. Mr. J. G. Sing, M. Can. Soc. C. E., District Engineer, Public Works Department, Toronto, has been appointed Consulting Engineer of the Harbor Board, but this will not interfere with his present work.

Mr. C. A. Delaney, for a number of years Superintendent of the Dickson Works of the American Locomotive Co., at Scranton, Penn., and recently Sales Representative at the same place, has been appointed Western Representative of the American Locomotive Co., with headquarters in the McCormick Bldg., Chicago, Ill.

Mr. F. C. Finkle has resigned as Consulting Engineer for the Southern California Edison Co., with which he has been associated since 1898. From 1898 to 1907 Mr. Finkle, as Chief Hydraulic Engineer of the company, designed and superintended the construction of seven hydro-electric power plants, the largest of which is the Kern River, No. 1, of 30,000 kw. rated capacity. Since 1907, Mr. Finkle has acted as Consulting Engineer for the company, which office he has resigned in order to devote his whole time to private practice.

Mr. Barton Cruikshank, former President of the Clarkson Memorial School of Technology, at Potsdam, N. Y., and at the time of his "decease" a member of the American Society of Mechanical Engineers, has reappeared in material form under the name of Donald Douglas, according to reports in the New York "Times." Mr. Cruikshank disappeared from his summer camp on the St. Lawrence River, in the summer of 1910, under conditions which gave every reason to believe he had been drowned while on a canoe trip. His wife, who was living with two children, at Morristown, N. Y., collected his life insurance, supposing him to be dead. Since that time it appears that he has conducted an engineering business at 30 Church St., New York City, under the name of Donald Douglas. Mr. Cruikshank was prominent as an engineer and widely known. For a number of years he was mechanical engineer with the Solvay Process Co., of Syracuse.

Mr. William A. Nettleton, M. Am. Soc. M. E., whose resignation as General Superintendent of Motive Power of the Chicago, Rock Island & Pacific Ry. was mentioned in our issue of last week, has completed nearly 27 years of railroading. He is a graduate of Yale University, class of 1885. Soon after graduation he entered the railway service as a rodman on the Kansas City, Fort Scott & Memphis R.R.; the following year he spent with the Westinghouse Air Brake Co., at Pittsburg, Penn., and in 1887 returned to the railway company as Inspector of Air Brakes. The following two years he was a bridge inspector at Athens, Penn., and New London, Conn. In 1889 he became Engineer of Tests of the Kansas City, Fort Scott & Memphis R.R. He remained with this railway until 1901, when the company was absorbed by the St. Louis & San Francisco R.R., having filled the positions of Superintendent of Terminals and Superintendent of Motive Power. In 1902 he was Assistant Superintendent of Motive Power of the Atchison, Topeka & Santa Fé Ry., and two years later General Superintendent of Motive Power of the St. Louis & San Francisco R.R. and of the Chicago & Eastern Illinois R.R., which position he left for his recent office with the Chicago, Rock Island & Pacific Ry.

Messrs. John F. Hayford, O. M. Leland, P. H. Ashmead and F. W. Hodgdon, Ms. Am. Soc. C. E., commissioners appointed last fall to settle the boundary dispute between the Central American republics of Costa Rica and Panama, sailed from New York for Bocas del Toro, Panama, on Jan. 13. Mr. Hayford is Dean of the Engineering School of Northwestern University and was for several years chief of the geodetic division of the United States Coast & Geodetic Survey; Mr. Leland is Assistant Professor of Civil Engineering of Cornell University and has been chief of party on the Canadian-Alaska boundary surveys; Mr. Ashmead is a consulting engineer, of New York City, and was formerly Chief Engineer of the famous Madeira-Mamoré Ry. in Brazil, and Mr. Hodgdon has been Chief Engineer of the Massachusetts Board of Harbor and Land Commissioners for a number of years. Accompanying the commissioners are Señors A. Bravo and L. Matamoros, engineers representing Panama and Costa Rica, respectively, and four assistant engineers and their parties, who will undertake the actual survey work. These assistant engineers are Messrs. E. R. Martin, W. F. Smith, J. W. Howard and W. F. Weakland. The survey is through a tropical jungle, largely mountainous, and is expected to require six or seven months of field work. The Chief Justice of the United States Supreme Court will act as sole arbitrator in finally establishing the boundary line.

## Obituary

Paul Taves, an American engineer who spent 45 years in Brazil as a builder of railways, died at Bournemouth, England, recently. He was 73 years old.

Capt. J. P. S. Lawrence, M. Am. Soc. M. E., died at his home in Washington, D. C., on Jan. 16. He was a retired engineer officer of the United States Navy and served in both the Civil and Spanish-American Wars.

Leroy A. Demarest, a graduate of Stevens Institute of Technology, class of 1907, died at his home in Hackensack, N. J., on Jan. 16, from spinal meningitis. He was 27 years of age, and prominent in his college life as an athlete.

Archibald G. Brownlee, M. Am. Inst. M. E., died at his home in Colorado Springs, Colo., on Jan. 16. He was born in Canada 55 years ago. He had been engaged in mining in British Columbia, Alaska and Colorado since 1890. He was a director and vice-president of the American Mining Congress.

Bernard N. Farren, Fellow of the American Society of Civil Engineers since 1870, formerly one of the most prominent contractors in the East, died at his home in Philadelphia, Penn., on Jan. 21. He was a contractor in the building of the Hoosac Tunnel, in Massachusetts, the Connecticut River dam at Turners Falls, Mass., and the Chestnut Hill reservoir of the Boston water supply.

George H. Massey, M. Can. Soc. C. E., Chief Engineer of the Reid Newfoundland Co., of Montreal, Que., died at his home in Westmount on Jan. 10. He was born in Tullow, Ireland, and came to Canada in 1871. For a number of years he was a bridge engineer with the Canadian Pacific Ry., and for the last years had been connected with the Reid Newfoundland Co. He is survived by widow and eight children.

John W. Young, M. Am. Inst. M. E., Second Vice-President of Chalmers & Williams, Inc., Chicago, Ill., died on Jan. 14, at his home in Evanston, Ill. He was born in Brooklyn, N. Y., and graduated from the Brooklyn Polytechnic Institute. In 1887 he went to Colorado and engaged in mining engineering. A short time later he became associated with the Fraser & Chalmers Co., and from 1900 to 1907 was European manager of the Allis-Chalmers Co., of Milwaukee, Wis. Since then he had been associated with Chalmers & Williams, Inc. He was 56 years old.

Daniel B. McCoy, formerly Superintendent of the Hudson division of the New York Central & Hudson River R.R., at New York City, died at his home in Hackensack, N. J., on Jan. 20. He was born Apr. 10, 1845, in Cambria County, Penn. He began railway work when a mere boy of 16 years, as a telegraph operator on the Pennsylvania R.R. He rose through the operating departments of the Pennsylvania; Pittsburg, Fort Wayne & Chicago; Chicago & Northwestern and Baltimore & Ohio Railways to the position of Division Superintendent of the West Shore R.R., in 1884. In 1890 he went to New York City as Superintendent of one of the most important divisions of the New York Central lines.

J. T. Harahan, former President of the Illinois Central R.R., was killed in a railway wreck at Kinmundy, Ill., on Jan. 22, as described elsewhere in this issue. Mr. Harahan was born in Lowell, Mass., in 1843. At 21 years of age he began railway work with the Orange & Alexandria R.R., in Virginia, when that state was still in the turmoil of civil war. Later he went to the Louisville & Nashville R.R., serving successively as Roadmaster, Division Superintendent, Assistant General Manager and General Manager. In 1888 he was made Assistant General Manager of the Lake Shore & Michigan Southern Ry. In 1890 he was successively General Manager of the Chesapeake & Ohio Ry., General Manager of the Louisville, New Orleans & Texas Ry., and Second Vice-President of the Illinois Central R.R., and in 1906 he was chosen President of the latter road, succeeding Mr. Stuyvesant Fish, of New York. Mr. Harahan retired on a pension in December, 1910, at the age of 67 years. Since then he had served as President of the Memphis Bridge & Terminal Co. He was a director of a number of railway and industrial corporations and a member of social organizations in Chicago, Louisville, New Orleans and other cities. Mr. W. J. Harahan, M. Am. Soc. C. E., Third Vice-President of the Erie R.R., is a son, and another son, J. T. Harahan, Jr., is a resident of Chicago.

Frank O. Melcher, Second Vice-President of the Chicago, Rock Island & Pacific Ry., was killed in a railway accident at Kinmundy, Ill., described elsewhere in this issue, on Jan. 22. Mr. Melcher was born in Maine in 1864. He graduated from Tufts College, Medford, Mass., in 1887, and received his C. E. degree there in 1895. In 1887 he began engineering work as an instrumentman on the Fitchburg R.R., now a part of the Boston & Maine R.R. In ten years he had been made Chief Engineer. Soon after he entered the operating department as

Division Superintendent and in a year became General Superintendent. In 1900, when the Fitchburg R.R. was absorbed by the Boston & Maine R.R., he remained as Superintendent of the Fitchburg division of the latter company. Two years later he joined the operating department of the Chicago, Rock Island & Pacific Ry. as Division Superintendent, from which position he rose rapidly to the office of Second Vice-President. Mr. Melcher was a remarkable example of the success that may attend an engineering graduate who possesses executive as well as engineering ability. His opening was through the engineering department of a small railway; but he was wise enough to step from an engineering position, which would have satisfied many men, into the operating department, which opened a much larger field for his genius.

## Engineering Societies

### COMING MEETINGS

INDIANA ENGINEERING SOCIETY.
Jan. 25-27. Annual meeting at Indianapolis, Ind. Secy., Charles Brossman, Union Trust Bldg., Indianapolis, Ind.

MAINE SOCEITY OF CIVIL ENGINEERS.
Feb. 7. Annual meeting at Lewiston, Me. Secy., F. E. Pressey, Augusta, Me.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 13-14. Annual meeting at New Haven, Conn. Secy., J. Frederick Jackson, Box 1304, New Haven, Conn.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 14-15. Annual meeting at Boston, Mass. Secy., N. W. Gifford, 26 Central Square, East Boston, Mass.

ENGINEERING SOCIETY OF WISCONSIN.
Feb. 14-16. Annual meeting at Madison, Wis. Secy., J. C. White, 624 E. Main St., Madison, Wis.

NORTH DAKOTA SOCIETY OF ENGINEERS.
Feb. 15-16. Annual meeting at Grand Forks, N. D. Secy., R. W. Livingston, Mandan, N. D.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting at Davenport, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

NATIONAL BRICK MANUFACTURERS ASSOCIATION.
Mar. 6-9. Annual convention at Chicago, Ill. Secy., T. A. Randall, Indianapolis, Ind.

NATIONAL ASSOCIATION OF CEMENT USERS.
Mar. 11-16. Annual convention at Kansas City, Mo. Secy., Edward E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN BOILER MANUFACTURERS ASSOCIATOIN.
Mar. 12-15. Annual convention at New Orleans, La. Secy., J. D. Farasey, East 37th St. and Erie R.R., Cleveland, Ohio.

**International Railway Fuel Association**—The fourth annual convention will be held at the Hotel Sherman, Chicago, Ill., May 22-25.

**Missouri Highway Engineers Association**—The next annual convention will be held in Kansas City, Mo., Mar. 14-21, during the Cement Show.

**Central Railway Club**—The annual meeting and dinner were held at the Statler Hotel, Buffalo, N. Y., on Thursday evening, Jan. 11, 1912.

**The American Waterworks Association**—The 32d annual convention will be held at Louisville, Ky., June 3-8, with headquarters at the Seelbach Hotel. The secretary, Mr. J. M. Diven, announces a change of address to 271 River St., Troy, N. Y.

**American Society of Engineer Draftsmen**—At the regular monthly meeting, to be held in the Engineering Societies Building, New York City, Jan. 18, Mr. Samuel J. Douglas, Chief Draftsman of the Evens & Howard Fire Brick Co., of St. Louis, Mo., presented a paper on "Clay Products," and Mr. Oscar J. Teale gave a lecture on "The Art of Perspective."

**Treasury Construction Society**—The third annual meeting will be held at the Treasury Department, Washington, D. C., Jan. 25-27. This society is composed of the superintendents of construction and other officials of the Supervising Architect's office, and the meeting is held for the reading and discussion of papers, and for the general interchange of views and experiences.

**American Chemical Society**—At the annual meeting in Washington, D. C., Dec. 27-30, Mr. Arthur T. Little, of Boston, Mass., was elected President of the Society. Mr. Little is a graduate of the Massachusetts Institute of Technology, Class of '85. He has previously held the position of Vice-President of the American Chemical Society, and has been Chairman of the Division of Industrial Chemists and Chemical Engineers.

**National Drainage Congress**—The annual meeting will be held at New Orleans, La., Apr. 10 to 13. Mr. E. T. Perkins, First National Bank Bldg., Chicago, Ill., is Vice-President.

**American Institute of Electrical Engineers**—Amendments to the constitution, providing for the establishment of a new scheme of membership grades was adopted at a meeting of the directors, on Jan. 12, for submission to the Institute. The Institute now has two grades; only 10% of the total membership is in the "member" grade and for several years a change has been advocated by many to establish a rank for those of the present "associates" who have higher professional and technical qualifications than required and a certain amount of engineering experience, leaving as future associates only those described by the present qualifications—persons "not less than 21 years of age, interested in or connected with the study or application of electricity." The present proposed amendments are the result of the work of committees appointed during four years past. The last committee decided not to follow the precedent of the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the British Institutions of Civil, Mechanical and Electrical Engineers, in having grades of "honorary members," "members," "associate members" and "associates." They followed instead the practice of the American Institute of Architects, the various bodies for the advancement of sciences and arts, in applying the title of "fellow" to the highest grade of regular membership. The proposed "fellow" class requires 10 years' experience and carries increased dues. Under the new scheme, the grade of "member" requires five years' experience, but does not insist on former length of time in actual charge of responsible work, provided the applicant is qualified to take such responsibility. The dues remain unchanged here and in the "associate" grade. Fellows, members and associates have the same right to vote, casting one ballot each.

Another amendment was adopted for reference to the membership, making the office of secretary an appointive one instead of elective. Mr. F. L. Hutchinson, formerly assistant secretary and recently acting secretary, was appointed secretary to fill the unexpired term of Ralph W. Pope, resigned.

The directors at this same meeting defined the status of sections of the Institute in the following by-law, which was recommended by the Public Policy Committee:

The principal work of a Section shall be the holding of regular meetings for the presentation and discussion of papers on matters relating to electricity, and to the allied arts and sciences, but no action which may purport to represent the policy or organization of the Institute, or of any Section, shall be published or communicated to any party or parties who are not members of the Institute, without the approval of the Board of Directors.

The directors added five names to the list of honorary members—the first given that honor since 1892. They were Prof. Andre Blondel, of Paris, France; Mr. C. E. L. Brown, of Baden, Switzerland; Dr. Emil Budde, of Berlin, Germany; Mr. Sebastian Ziani de Ferranti, of London, England, and Prof. Antonio Pacinotti, of Pisa, Italy.

**American Society for Testing Materials.**—On account of the sixth International Congress for Testing Materials, which will be convened in New York City, Sept. 3, 1912, the next annual meeting of the American Society will be held March 28-29, in New York City, instead of at the usual time in June. The total membership of the American Society is now 1397. The American membership of the International Association is 571, an increase of over 100 during the past six months.

**Wood Preservers Association**—The annual meeting was held at the Sherman Hotel, Chicago, Jan. 16-18. The attendance was very good, nearly 160 members and visitors being registered. We shall publish abstracts of several of the papers. The election of officers resulted as follows: President, E. A. Sterling, Philadelphia, Penn.; Vice-Presidents, Amos Smith, Argenta, Ark., H. M. Rollins, Gulfport, Miss., and G. B. Shipley, Pittsburg, Penn.; Secretary, F. J. Angier, Baltimore & Ohio R.R., Baltimore, Md. The next meeting will be held at Chicago in January, 1913.

**International Congress of Engineers**—A conference was held in San Francisco, Jan. 15, to make plans for an engineers' congress to be held in that city in 1915, at the time of the World's Exposition to celebrate the opening of the Panama Canal. Among the societies represented at the conference were the Society of Naval Architects and Marine Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Testing Materials, American Institute of Mining Engineers, the Mining & Metallurgical Society of America and the American Chemical Society. The chairman of the meeting was Prof. W. W. Durand, of Leland Stanford, Jr., University.

**Brooklyn Engineers' Club**—At the first regular meeting of the year, held Jan. 11, Mr. Frederick L. Cranford, a prominent subway contractor of New York, presented a paper on "The Relation of the Engineer to the Present Industrial Problem." Mr. Cranford discussed, under seven headings each, the advantages and disadvantages of great industrial organizations, taking the stand that such combinations had come to stay and that the successful outcome of the problem rested in some de-

gree with the engineers, as educated and intelligent citizens.

Following the paper, a number of members engaged in a discussion of the relative abilities of lawyers and engineers as executive and business men, a discussion in which the lawyer appeared to have few defenders in the audience.

**Canadian Mining Institute**—The fourteenth annual meeting will be held at Ottawa, Canada, March 6-8. The headquarters will be at the new Russell House. The provisional program includes the following papers: "Monel Metal," Dr. W. Campbell, Columbia University, New York; "The Evans-Stansfield Electric Furnace," J. W. Evans, Belleville, Ont.; "Artificial Ventilation in Metal Mines," Frank C. Loring, Toronto; "A New Departure in Mining Education," H. G. Carmichael, Sudbury; "Safety Appliances for Prevention of Accidents in Mines," W. H. Tolman, New York. The secretary is Mr. H. Mortimer Lamb, Room 3, Windsor Hotel, Montreal, Que.

**Ohio Electric Light Association**—The 18th annual convention will be held at Cedar Point, Ohio, July 16-19. The program will include committee reports on Electrical Transmission, Meters, Insurance, Costs, and a paper on "Purification of Sewage by Electricity," by F. C. Caldwell, of Columbus. A paper entitled the "Public Utility and its Relation to the Public" will be presented by D. L. Gaskill, of Greenville.

An innovation in the manner of presenting papers will be tried at this convention. All the papers will be sent to the members of the association in advance of the sessions at which they will be read, and the discussion of the paper will immediately follow the announcement of the paper by title. This plan is intended to give more time for the discussion and to enable those attending the meeting to prepare their discussions in advance.

**American Society of Civil Engineers**—The association of members of this Society resident in Washington and vicinity gave a dinner in Washington, on Saturday evening, Jan. 20, in honor of the retiring President, Admiral Endicott, and the incoming President, Col. J. A. Ockerson. The President of the Association, Mr. Arthur P. Davis, Chief Engineer of the U. S. Reclamation Service, acted as toastmaster, and the after-dinner speakers besides Messrs. Endicott and Ockerson were Past President Desmond Fitzgerald, of Boston; Frederick H. Newell, Director, U. S. Reclamation Service; Charles Whiting Baker, editor-in-chief of Engineering News, and Marshall O. Leighton, Chief Hydrographer, U. S. Geological Survey.

**American Society of Civil Engineers**—At the regular meeting of the Colorado Association of members of this society, held at Denver, Colo., Jan. 13, Mr. Burgis D. Coy presented a paper on "The Larimer Poudre Tunnel."

**Wisconsin Electrical Association**—At the fourth annual convention to be held at Milwaukee, Wis., Jan. 18 to 19, the following papers were presented: "Commercial Development of the Central Station Business," Egbert Douglass; "Power Solicitation in a City of 20,000," A. E. Peirce; "Workmen's Compensation Law," C. H. Crownhart; "Industrial Insurance from the Standpoint of the Public Utility," P. H. Korst; "Review of Recent Legislation Affecting Public Utilities," Arthur W. Fairchild; "The New Cold Spring Shops of the Milwaukee Electric Railway & Light Co.," R. H. Pinkley; "Recent Electrical Railway Developments," J. L. Davis; "Improvement in the Art of Street Illumination," W. D. A. Ryan; "The Work of Chief Accountant of a Public Utility in a City of 20,000 People," F. J. Maxwell; "The Relation of Central Stations to the Wiring and Supply Business," W. B. Voth; "Latest Development in Electric Heating and Cooking Devices," J. D. A. Cross; "Electric Utilities," C. N. Duffy; "Relative Merits of Single and Multiphase Distribution of Power for Relatively Small Installations," E. H. Cheney; "Dispatching and Handling Street Cars and Train Crews," Edward Hammett.

**American Public Health Association**—A meeting for the organization of a Sanitary Engineering Section of the Association, which was authorized at Havana in December, 1911, was held at the rooms of the American Society of Civil Engineers, on Jan. 18. A constitution was adopted and officers were elected. According to the Constitution, such members of the Association as sanitary engineers in active practice of their profession, and other members of the Association holding, or having held, professional relation to the technical aspects of sanitary engineering, may become members of the Sanitary Engineering Section on election by the Council of the Section. Besides the presentation and discussion of papers, the objects of the Association, as stated in the Constitution, are as follows:

The promotion of a closer coöperation between the medical and engineering professions on all questions relating to the furnishing of potable water supplies, to the collection, the removal and safe disposal of sewage, garbage and other wastes, to the prevention of objectionable pollution of water courses, to the preservation and establishment of healthful atmospheric and other hygienic conditions within and adjacent to inhabited districts, and to the subjects of ventilation, heating, lighting and plumbing of inclosed spaces.

**American Museum of Safety**—The second annual meeting was held at the Engineering Societies Building in New York City on Thursday evening, Jan. 18. Three gold medals were awarded at this meeting. The Travelers Insurance Co. medal for the American employer who has done the most for the protection of his workmen by means of safety devices was awarded to the Pennsylvania R.R. Co. In the fall of 1910 experts from one of the large accident insurance companies were employed by this railroad to inspect all of its larger shops and make recommendations as to what should be done to increase the safety measures then in force. The result of this campaign was a decrease in serious injuries, per one thousand shop employees, from 8.7 in January to 3.2 in October. During this period the average number of shop employees was 33,242.

The Scientific American medal for the most efficient safety device exhibited at the Museum's hall during the past three years was awarded to the Norton Co., of Worcester, Mass. The award of the Louis Livingston Seaman medal for progress and achievement in the promotion of hygiene and sanitation and the mitigation of occupational disease was made to Dr. A. H. Doty, health officer of the port of New York.

**American Society of Engineering Contractors**—The third anual meeting and election of officers took place in New York City on Jan. 9, in the forenoon, through the courtesy of Mr. W. L. Morse, Terminal Engineer of the New York Central & Hudson River R.R., the members of the society were taken on an inspection tour of the new Grand Central terminal now in the course of construction. The annual business meeting was held in the afternoon of the same day. Besides the routine business there was also an interesting discussion on the collection of cost data. A number of members expressed a disinclination to publish their own collections of cost data, from a feeling that this would be giving too great an advantage to their business rivals.

In the evening the newly elected President, Maj. Cassius E. Gillette, made a short address outlining the needed work of the society. The remainder of the evening was devoted to a talk by Mr. J. R. Wemlinger on "Methods and Costs of Driving and Pulling Steel Sheet Piling," illustrated by many lantern slides.

The officers elected for the ensuing year are: President, Maj. C. E. Gillette, Philadelphia, Penn.; Vice-Presidents, H. J. Cole, City Engineer, of Morristown, N. J., and Mr. John Marshall, City Engineer, of Regina, Canada. The Secretary is Mr. J. R. Wemlinger, Park Row Bldg., New York City.

**International Congress of Navigation**—The twelfth congress, which will convene in Philadelphia, May 23, will be the first of the International Navigation congresses to be held in America. Previous congresses have been held at intervals of about four years since 1885 in Belgium, Holland, England, Germany, Italy, France, Austria and Russia, and the permanent association which conducts these congresses now includes 35 nations in its membership.

The proceedings of the congress at Philadelphia will be divided into two sections, one on inland waterways and the other on ocean navigation. The subjects to be discussed will include the equipment of ports with mechanical facilities for freight handling, the most economical and profitable dimensions for barge canals, the dimensions for ship canals, such as those of Panama, Suez, and the Kaiser Wilhelm Canal, in Germany, the probable dimension of ocean steamships of the future, the control and improvement of navigable rivers, means for docking and repairing vessels and the use of concrete for canal locks and harbor works.

The membership of the permanent association includes both those who are engaged in working out the theoretical and technical problems of navigation, and freight shippers who are interested in navigation as a means of transportation. In addition to the membership of the permanent association, provision is made for temporary membership for the one congress which may be had by the payment of a small fee and entitles the temporary member to a seat in the congress and to receive all the printed reports of proceedings. Applications for membership should be made to the General Secretary of the Congress, Col. J. C. Sanford, The Bourse, Philadelphia, Penn.

**Kansas Engineering Society**—The second annual meeting was held at Manhattan, Kan., Jan. 23-24. Among the papers presented were the following: "The Work of the Engineering Department of the Kansas Public Utilities Commission," C. C. Witt, Topeka; "The Contamination of City Wells," C. S. Loper, Topeka; "Concrete Pavements," J. H. Titus, Wichita; "Notes on a Piece of Screw-Spike Track," Geo. J. Graves, Dodge City; "The Use and Abuse of Sewage Disposal Plants," Chester A. Smith, Kansas City, Mo.